

DESCRIPTION

SUPPORT STRUCTURE AND MEMBRANE FILTRATION DEVICE

5 TECHNICAL FIELD

[0001] The present invention relates to a supporting structure of a membrane element and a membrane filtration device that can be applied to various facilities such as sewage treatment and industrial wastewater treatment.

10 BACKGROUND ART

[0002] As an example of a liquid-solid separation system that can be applied to various facilities such as sewage treatment and industrial wastewater treatment, a membrane filtration device using a membrane separation technology is known. This membrane filtration device is immersed in a liquid phase, for instance, in a biological treatment tank or a coagulation treatment tank (or a flocculation treatment tank), then treated water treated in the tank can be solid-liquid-separated into solid substances and water components.

[0003] For solid-liquid separation of the treated water, for instance, a membrane element having a filtration main body used for membrane separation, a water collection portion that collects treated water (filtered treated water) having undergone the membrane separation from an end portion of the filtration main body and a treated water lead-out portion that leads out the treated water coming from the water collection portion is used. By connecting a water collection pipe to this treated water lead-out portion of the membrane element, the treated

water solid-liquid-separated by the membrane element can be collected in the water collection pipe, then taken out to the outside (e.g. a place where a treatment process in a subsequent stage of the membrane filtration device is performed).

[0004] When such membrane filtration device is immersed in a liquid phase, for instance, various deposits adhere to the membrane element etc. according to operating conditions. For this reason, for the membrane element etc., a cleaning process is performed as necessary, for instance, by performing air-washing of surfaces of the membrane element etc. using e.g. an air diffuser or by performing backwashing (back-pressure washing) of the membrane element etc. by temporarily reversing flow of the treated water in the membrane element and in the water collection pipe.

[0005] Further, since various stresses are applied to the membrane element according to the operating conditions of the membrane filtration device, it is desirable to appropriately support the membrane element.

[0006] Patent Document 1 discloses a structure in which a holding plate (or a pressing plate) (denoted by a reference sign 14 in Patent Document 1) that supports each membrane element is provided at an upper side of a membrane module formed by the plurality of arranged membrane elements. Patent Document 1 further discloses that this holding plate has comb-shaped projections (denoted by a reference sign 16a in Patent Document 1), each of which is press-fitted into a gap between the adjacent membrane elements.

[0007] According to such supporting structure of Patent Document 1, vibrations in a vertical direction of the membrane element are suppressed during the air-washing, then sliding movement between the membrane element and a peripheral portion and wear of the membrane element due to the sliding movement can be prevented.

[0008] Patent Document 2 discloses a structure in which comb-shaped guide members (denoted by reference signs 70 and 71 in Patent Document 2) that guide loading and unloading of the membrane element into and from a rack of a membrane filtration device are provided. Patent Document 2 further discloses a structure in which by fitting space maintaining members (denoted by a reference sign 65 in Patent Document 2) to supporting portions (denoted by reference signs 51a and 51b in Patent Document 2) provided at sides (both sides) of each membrane element accommodated in the rack, each membrane element is supported.

[0009] According to such supporting structure of Patent Document 2, the membrane element can be easily unloaded.

CITATION LIST

PATENT DOCUMENT

[0010]

Patent Document 1: Japanese Unexamined Patent Application Publication No. H10-137556

Patent Document 2: Japanese Unexamined Patent Application Publication No. 2009-148743

SUMMARY OF THE INVENTION

[0011] In the case of the supporting structure of Patent Document 1, even if the vibrations etc. of the membrane

element can be suppressed, loading and unloading of each membrane element becomes difficult due to a frictional force between each membrane element and the holding plate, which results in poor handling workability.

5 [0012] In the case of the supporting structure of Patent Document 2, since the sides of the membrane element are supported (the both sides at standing-direction middle portions of the membrane element are supported in Fig. 1 of Patent Document 2), there is a risk that membrane
10 element's own flexibility will be reduced.

[0013] When the flexibility of the membrane element is reduced, in a case where stress is applied to the membrane element, the membrane element is difficult to bend (it is difficult to disperse the stress), then there is a
15 risk that the membrane element will be overloaded.

[0014] The present invention was made in view of the above technical problems. An object of the present invention is therefore to provide a technique that can contribute to improvement in the handling workability of the membrane
20 element and the flexibility of the membrane element.

[0015] A supporting structure and a membrane filtration device according to the present invention can contribute to solution to the above problems. As one aspect of the supporting structure according to the present invention,
25 a supporting structure comprises: membrane modules formed by a plurality of membrane elements arranged at predetermined intervals in a horizontal direction, each of the membrane elements having a filtration main body used for membrane separation, a water collection portion
30 that collects treated water having undergone the membrane

separation from an upper end portion of the filtration main body and a treated water lead-out portion that leads out the treated water coming from the water collection portion; a rack having a shape in which the membrane modules
5 can be accommodated and having accommodating sections into and from which each of the membrane elements can be loaded and unloaded; and a water collection pipe having a tubular peripheral wall that extends in an arrangement direction of the membrane elements accommodated in each
10 accommodating section and collecting the treated water led out from the treated water lead-out portions with the treated water lead-out portion of each membrane element being connected to the tubular peripheral wall.
[0016] Each accommodating section of the rack has an
15 accommodation opening which is open to one side in a crossing direction crossing the arrangement direction of the membrane elements among the horizontal direction and through which each membrane element can be loaded and unloaded in the crossing direction, and a pair of
20 lower-side supporting portions extending in the arrangement direction of the membrane elements and arranged parallel to each other in the crossing direction. Each lower-side supporting portion has a lower-side base body extending in the arrangement direction of the
25 membrane elements and supporting a lower end portion of each membrane element in the accommodated state, and a plurality of lower-side rock suppression walls provided at the lower-side base body at positions arranged at predetermined intervals in the arrangement direction of
30 the membrane elements and having a shape projecting upward

from respective arrangement positions of the lower-side rock suppression walls. Each membrane element in the accommodated state is interposed between adjacent two lower-side rock suppression walls.

5 [0017] In the above aspect, the lower-side rock suppression wall is provided so that a clearance is formed between the membrane element in the accommodated state and the lower-side rock suppression wall adjacent to the membrane element.

10 [0018] Further, the lower-side supporting portions support both end edge portions in the crossing direction of the lower end portion of each membrane element in the accommodated state, and a lower-side shielding portion that shields an outer side in the crossing direction of
15 the lower-side supporting portion is detachably provided at the outer side in the crossing direction of at least one of the lower-side supporting portions.

[0019] Further, two accommodating sections of the rack are located on opposite sides of the tubular peripheral
20 wall in a posture in which the two accommodating sections face each other at their back surface sides that are opposite sides to the respective accommodation openings, and the membrane module is accommodated in each accommodating section.

25 [0020] Furthermore, each accommodating section of the rack further has an upper-side bridge portion extending in the arrangement direction of the membrane elements. And, the upper-side bridge portion has an upper-side base body extending in the arrangement direction of the
30 membrane elements and engaged with the upper end portion

of each membrane element in the accommodated state, and a plurality of upper-side rock suppression walls provided at the upper-side base body at positions arranged at predetermined intervals in the arrangement direction of the membrane elements and having a shape projecting downward from respective arrangement positions of the upper-side rock suppression walls. And, each membrane element in the accommodated state is interposed between adjacent two upper-side rock suppression walls.

10 [0021] In addition, the upper-side rock suppression wall is provided so that a clearance is formed between the membrane element in the accommodated state and the upper-side rock suppression wall adjacent to the membrane element.

15 [0022] Moreover, the tubular peripheral wall has at an upper side in a radial direction thereof, a thick portion that is thicker in the crossing direction among the radial direction of the tubular peripheral wall, and a connecting hole that penetrates the thick portion in an inward-and-outward direction of the tubular peripheral wall. And, the treated water lead-out portion is provided at another side in the crossing direction of the water collection portion, and connected to the connecting hole in the accommodated state and communicates with an inside of the tubular peripheral wall.

25 [0023] As one aspect of the membrane filtration device according to the present invention, in a membrane filtration device having any one of the above supporting structures, the rack is provided, at a lower side of the

accommodating section, with an air diffuser having a plurality of air blow holes.

[0024] According to the present invention described above, it is possible to contribute to improvement in the handling workability of the membrane element and the flexibility of the membrane element.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

Fig. 1 is a schematic view (a schematic perspective view) for describing an example of a membrane filtration device according to the present embodiment (membrane modules 30 formed by membrane elements 3 are omitted, and a rack 1 and water collection pipes 2 are mainly illustrated). Fig. 2 is a schematic view for describing an example of the water collection pipe 2.

Fig. 3A is a schematic view for describing an example of the membrane element 3. Fig. 3B is a local schematic view of a footer 33 when viewed from the outside in an arrow X1X2 direction.

Fig. 4 is a schematic view (corresponding to a sectional view of a main part of the water collection pipe 2, cut in the arrow X1X2 direction of Fig. 1, illustrating a state in which the water collection pipe 2 and the membrane element 3 are not connected) for describing an example of a connecting structure between both of the water collection pipe 2 and the membrane element 3.

Fig. 5 is a schematic view for describing an example of the membrane module 30 in an accommodated state (a local perspective view illustrating a case where the membrane

module 30 is accommodated in an accommodating section 11B in the rack 1).

Fig. 6A and 6B are schematic views depicting a part of the membrane module 30 in the accommodated state shown in Fig. 5. Fig. 6A is a local perspective view depicting a region in which five membrane elements 3 are arranged. Fig. 6B is a local perspective view depicting an arrow Z2 direction side of Fig. 6A when viewed from a different angle.

Fig. 7 is a schematic view (corresponding to a sectional view of a main part of the water collection pipe 2, cut in the arrow X1X2 direction of Fig. 1, illustrating a state in which the water collection pipe 2 and the membrane element 3 are not connected) for describing another example of the connecting structure between both of the water collection pipe 2 and the membrane element 3 according to the present embodiment.

EMBODIMENTS FOR CARRYING OUT THE INVENTION

[0026] A supporting structure and a membrane filtration device according to an embodiment of the present invention are completely different from configurations having the supporting structures as disclosed in Patent Documents 1 and 2.

[0027] That is, in the supporting structure and the membrane filtration device according to the present embodiment, an upper end portion and a lower end portion of each of a plurality of membrane elements accommodated in each accommodating section in a rack are supported.

[0028] More specifically, the upper end portion of each membrane element is supported by being connected to a

water collection pipe that collects treated water having undergone membrane separation of the membrane element (i.e. by connecting an after-mentioned treated water lead-out portion 34 shown in Fig. 3A to an after-mentioned
5 connecting hole 23). Also, the lower end portion of each membrane element is supported by a pair of lower-side supporting portions that have a shape extending in an arrangement direction of the membrane elements (in an arrow Y1Y2 direction in Fig. 1) and that are arranged
10 parallel to each other in a crossing direction (in an arrow X1X2 direction in Fig. 1) crossing the arrangement direction of the membrane elements.

[0029] The lower-side supporting portion has the shape extending in the arrangement direction of the membrane
15 elements. The lower-side supporting portion has a lower-side base body that supports the lower end portion of each membrane element in a state in which each membrane element is accommodated in the accommodating section (hereinafter referred to simply as an accommodated state),
20 and a plurality of lower-side rock suppression walls (or a plurality of lower-side wobble suppression walls) that are provided at the lower-side base body at positions arranged at predetermined intervals in the arrangement direction of the membrane elements and that each have
25 a shape projecting upward from the arrangement position.

[0030] Then, as a structural feature, each membrane element in the accommodated state is interposed between the adjacent two lower-side rock suppression walls.

[0031] According to such supporting structure of the
30 present embodiment, since there is no need to support

a middle portion located between the upper end portion and the lower end portion of the membrane element in the accommodated state (for instance, there is no need to support the side portion(s) like Patent Document 2),
5 membrane element's own flexibility tends to be maintained.

[0032] With this, when stress is applied to the membrane element in the accommodated state, the membrane element is easy to bend (it is easy to disperse the stress), thereby suppressing a load (e.g. an impact by continuous aeration
10 energy during the air-washing or a load due to a temporary impact such as an earthquake etc.) applied to the membrane element.

[0033] Further, regarding the pair of lower-side supporting portions supporting the lower end portion of
15 each membrane element in the accommodated state, although the lower-side rock suppression wall is interposed between the adjacent two membrane elements (for instance, the lower-side rock suppression wall is interposed between the adjacent two membrane elements with a clearance formed
20 between them), there is no member like Patent Document 1 (denoted by a reference sign 16a in Patent Document 1) that is press-fitted into the gap between the adjacent two membrane elements. Therefore, it is possible to suppress a frictional force between the lower-side
25 supporting portion and the membrane element (as compared with the Patent Document 1), then the loading and unloading of the membrane element can be readily done.

[0034] Thus, according to the supporting structure of the present embodiment, it is possible to contribute to

improvement in the handling workability of the membrane element and the flexibility of the membrane element.

[0035] As the supporting structure and the membrane filtration device according to the present embodiment, as described above, the upper end portion and the lower end portion of the membrane element in the accommodated state are supported, then it is possible to contribute to improvement in the handling workability of the membrane element and the flexibility of the membrane element. As long as the supporting structure and the membrane filtration device have such configuration, common technical knowledge in various fields (e.g. a field of membrane separation technology or piping technology that are applied to various facilities) could be used as necessary, and also design change could be possible by referring to the prior art documents if necessary.

[0036] <<Membrane filtration device 10 as an example of the present embodiment>>

Figs. 1 to 6 are drawings for describing the connecting structure and the membrane filtration device 10 having the connecting structure according to the present embodiment. In Figs. 1 to 6, an arrow Z1Z2 direction corresponds to an installation direction of the membrane filtration device 10, and the arrow X1X2 direction and an arrow Y1Y2 direction each indicate the horizontal direction. Further, in Figs. 1 to 6, the same element or component is denoted by the same reference sign, and its explanation will be omitted below.

[0037] <Main configuration of membrane filtration device 10>

As shown in Fig. 1, the membrane filtration device 10 has a rack 1 whose plurality of frames (frames 1a, 1b and 1c in Fig. 1) are assembled into an enclosure and long strip-shaped water collection pipes 2A and 2B provided so as to extend in the arrow Y1Y2 direction in an upper space 1A and a lower space 1B in the rack 1 respectively. Further, membrane modules 30 (membrane modules 30 accommodated in after-mentioned accommodating sections 11A, 12A, 11B and 12B respectively in Fig. 1), each of which is formed by a plurality of membrane elements 3 (described later using Fig. 3A) arranged at predetermined intervals in the arrow Y1Y2 direction (in an axial direction of a tubular peripheral wall), are accommodated in the rack 1.

[0038] The rack 1 shown in Fig. 1 has a structure in which the plurality of frames 1a extending in the arrow X1X2 direction, the plurality of frames 1b extending in the arrow Y1Y2 direction and the plurality of frames 1c extending in the arrow Z1Z2 direction are assembled into the enclosure, and can support each component (e.g. the water collection pipes 2A and 2B, the membrane elements 3 and an air diffuser (not shown)) of the membrane filtration device 10. Material constituting the rack 1 is not particularly limited. For instance, metal material such as stainless steel and a variety of resin materials could be used.

[0039] In the upper space 1A located at an arrow Z2 direction side in the rack 1, the water collection pipe 2A is provided at a position on the arrow Z2 direction side and in the middle in the arrow X1X2 direction so

as to extend in the arrow Y1Y2 direction. Further, the accommodating sections 11A and 12A are arranged on opposite sides of the water collection pipe 2A so as to face each other in the upper space 1A.

5 [0040] In the same manner as the upper space 1A, in the lower space 1B located at an arrow Z1 direction side in the rack 1, the water collection pipe 2B is provided at a position on the arrow Z2 direction side and in the middle in the arrow X1X2 direction so as to extend in the arrow
10 Y1Y2 direction. Further, the accommodating sections 11B and 12B are arranged on opposite sides of the water collection pipe 2B so as to face each other in the lower space 1B.

[0041] The accommodating sections 11A, 12A, 11B and 12B
15 are each provided, at outer sides in the arrow X1X2 direction thereof, with an accommodation opening 16 that is open to the respective outer sides in the arrow X1X2 direction. Each membrane element 3 of the membrane module 30 can be accommodated in the respective accommodating
20 sections 11A, 12A, 11B and 12B through the accommodation opening 16 so as to be able to be loaded and unloaded in the arrow X1X2 direction. With this configuration, for instance, the accommodating sections 11A and 12A located on opposite sides of the water collection pipe
25 2A face each other at their back surface sides that are opposite sides to the respective accommodation openings 16.

[0042] Further, the accommodating sections 11A, 12A, 11B and 12B are each provided, at the arrow Z1 direction sides
30 thereof, with a pair of supporting frames 15 that are

spaced a predetermined distance and extend in the arrow Y1Y2 direction. Each of the pair of supporting frame 15 has a lower-side supporting portion 4 (described later using Figs. 5 and 6A) having a shape extending in the arrow Y1Y2 direction. With this structure, a lower end portion (e.g. an after-mentioned footer 33) of each membrane element 3 of the accommodated membrane module 30 can be supported by the lower-side supporting portions 4.

10 [0043] In addition, the accommodating sections 11A, 12A, 11B and 12B are each provided, at arrow Z2 direction sides of the respective accommodation openings 16, with an upper-side bridge portion 5 (described later using Figs. 6A and 6B) extending in the arrow Y1Y2 direction. With this structure, an upper end portion (e.g. an after-mentioned header 32) of each membrane element 3 of the accommodated membrane module 30 can be supported by the upper-side bridge portion 5.

[0044] Shielding panels 13 and 14 are provided at each side portion in the horizontal direction of the accommodating sections 11A, 12A, 11B and 12B so as to shield outer peripheral sides of the membrane modules 30 accommodated in the accommodating sections 11A, 12A, 11B and 12B. With these shielding panels 13 and 14, for instance, bubbles by an after-mentioned air diffuser are prevented from coming out to the outside from each side portion in the horizontal direction of the accommodating sections 11A, 12A, 11B and 12B.

[0045] The air diffuser(s) (not shown) having e.g. a plurality of air blow holes is (are) provided in the rack

1, for instance, at a lower side(s) with respect to the accommodating sections 11A, 12A, 11B and 12B (at the arrow Z1 direction side of the lower space 1B in Fig. 1). For instance, by blowing the air from each air blow hole of the air diffuser in a state in which the membrane filtration device 10 is immersed in a liquid phase, bubbles can be generated in the rack 1.

[0046] The bubbles rise in the arrow Z2 direction, for instance, along each surface of the membrane element 3 of the membrane module 30 (e.g. between adjacent membrane elements 3) and generate a shearing force when coming into contact with the surfaces of the membrane element 3, then the surfaces of the membrane element 3 are cleaned with air (for instance, deposits are removed).

15 [0047] <Configuration of water collection pipes 2A and 2B>

As shown in Figs. 2 and 4, each of the water collection pipes 2A and 2B mainly has a long strip-shaped tubular peripheral wall 21 having an inner peripheral surface 21a which is substantially circular in radial direction cross section and a plurality of connecting holes 23 arranged in the arrow Y1Y2 direction (in an axial direction of the tubular peripheral wall 21) at an upper-side peripheral wall portion 22 located at the arrow Z2 direction side of the tubular peripheral wall 21 (at an upper side in the radial direction of the tubular peripheral wall 21).

[0048] The tubular peripheral wall 21 has, at the upper-side peripheral wall portion 22, thick portions 24 that are thicker in the arrow X1X2 direction (in the

horizontal direction among the radial direction of the tubular peripheral wall 21), and the thick portion 24 is substantially trapezoidal in radial direction cross section.

5 [0049] Each connecting hole 23 is provided at a position facing a treated water lead-out portion of the membrane element 3 in the accommodated state so as to penetrate the thick portion 24 in the inward-and-outward direction (in the arrow X1X2 direction) of the tubular peripheral
10 wall 21.

[0050] Of all outer peripheral surfaces of the tubular peripheral wall 21, strip-shaped grooves 26 extending in the arrow Y1Y2 direction are formed at positions on outer peripheral edge surfaces at the arrow Z1Z2 direction
15 side of the connecting hole 23 of the upper-side peripheral wall portion 22 (at positions on outer peripheral edge surfaces at the arrow Z1 direction side in Figs. 2 and 4). Further, shock absorbing materials (e.g. rubber sheets) 26a are provided at the respective strip-shaped
20 grooves 26 so as to fill the respective strip-shaped grooves 26. Then, with the shock absorbing material 26a, for instance, even if the tubular peripheral wall 21 and the after-mentioned header 32 collide with each other, the shock of the collision can be absorbed.

25 [0051] By opening an end portion, for instance, at the arrow Y1 direction side of the tubular peripheral wall 21 and providing a pipe 27 etc. at the end portion as shown in Fig. 1, treated water collected in the tubular peripheral wall 21 can be taken out to the outside (e.g.

a place where a treatment process in a subsequent stage of the membrane filtration device 10 is performed).

[0052] A shape of the water collection pipes 2A and 2B (for instance, an outside diameter and an inside diameter of the tubular peripheral wall 21, a length in the arrow Y1Y2 direction of the tubular peripheral wall 21), a shape (for instance, a diameter of the hole (a hole size)) of the connecting hole 23 and arrangement and the number of the connecting holes 23 can be appropriately set according to an amount of the treated water and so on of the membrane filtration device 10 provided with the membrane elements 3.

[0053] Material constituting the water collection pipes 2A and 2B is not particularly limited. For instance, it could be metal material such as stainless steel, resin materials such as polyethylene, polypropylene and polyvinyl chloride, composite material of polyvinyl chloride and fiber-reinforced plastics, composite material of polyethylene and fiber-reinforced plastics and so on, and these materials can be appropriately selected and used.

[0054] Further, by using various molding techniques such as injection molding, extrusion molding and cutting process using the above material, it is possible to form the water collection pipes 2A and 2B having non-divided structure (non-dividable structure) without dividing the pipe in the axial direction (in the arrow Y1Y2 direction) as shown in Figs. 2 and 4.

[0055] Here, for instance, it could be possible to form the water collection pipes 2A and 2B having a multi-stage

structure (i.e. the water collection pipe that can be divided in the axial direction) in which a plurality of tubular bodies are arranged in the axial direction. However, in this case, it is required to maintain desired liquid-tightness by interposing a sealing member between the tubular bodies.

[0056] <Configurations of membrane element 3 and membrane module 30>

As shown in Figs. 3 and 4, the membrane element 3 mainly has a filtration main body 31, the header 32 and the footer 33. In a case of this membrane element 3 shown in the drawings, the membrane element 3 has a long flat-plate shape extending in the arrow Z1Z2 direction, and has a structure having such flexibility that, for instance, the middle of the filtration main body 31 bends moderately or to a certain extent in the arrow Y1Y2 direction.

[0057] The filtration main body 31 is used for solid-liquid separation, and is formed using e.g. a flat filtration member. Inside this filtration member, flow passages or flow gaps are formed as spaces where filtered water obtained by the solid-liquid separation flows. The filtration member is not particularly limited as long as the filtration member has a filtering function, and various shapes or structures can be used. As an example, it could be a structure in which filtration membranes are formed on surfaces (flat main surfaces at the arrow Y1Y2 direction sides of the filtration main body 31) of a water-permeable flat supporting body.

[0058] The header 32 and the footer 33 are liquid-tightly fixed to one end portion and the other end portion of

the filtration main body 31 respectively, for instance, by adhesion, welding or molding.

[0059] The header 32 functions as a water collection portion that collects the treated water of the

5 solid-liquid separation from the one end portion of the filtration main body 31. The header 32 is provided, at one end portion thereof (at an end portion in the arrow X2 direction of the header 32 in Fig. 3), with a treated water lead-out portion 34 made of a pipe-shaped member.

10 This treated water lead-out portion 34 is connected to the connecting hole 23 of the tubular peripheral wall 21 with the treated water lead-out portion 34 being fitted into the connecting hole 23, then the treated water solid-liquid-separated by the membrane element 3 can be
15 led out into the tubular peripheral wall 21.

[0060] In a case of the treated water lead-out portion 34 shown in Fig. 4, the treated water lead-out portion 34 has a liquid-tight portion 34a that is inserted into the connecting hole 23 of the tubular peripheral wall

20 21 and a fitting portion 34b that is provided at the one end portion of the header 32 and fitted into the connecting hole 23. Water-sealing members 34c that liquid-tightly seal a gap between the liquid-tight portion 34a and the connecting hole 23 are attached to or fitted onto an outer
25 peripheral surface of the liquid-tight portion 34a.

[0061] Materials constituting the filtration main body 31, the header 32 and the footer 33 are not particularly limited. For instance, they could be metal used for solid-liquid separation technology, well-known

30 inorganic material such as ceramic and well-known organic

material such as polymeric resin (high polymer resin).
Further, these materials are appropriately selected and
used so as to have a strength enough to prevent damage
by, for instance, gas-liquid mixed flow for cleaning the
5 filtration main body 31 when the filtration main body
31, the header 32 and the footer 33 are installed as a
membrane separation device.

[0062] As material constituting the treated water
lead-out portion 34, the same material as those of the
10 filtration main body 31, the header 32 and the footer
33 could be used. Although this treated water lead-out
portion 34 has a cylindrical shape, the treated water
lead-out portion 34 may have a polygon such as a triangle
and a quadrangle in cross section, except for a circle.
15 Further, by forming the fitting portion 34b into a tapered
shape, it is possible to contribute to improvement in
liquid-tightness. As the water-sealing member 34c, a
well-known elastic member such as an O-ring used for water
treatment technology can be used.

20 [0063] Shapes etc. of the header 32 and the footer 33
are not particularly limited as long as the header 32
and the footer 33 can be supported so as to perform their
functions, and the shapes etc. can be appropriately set.
For instance, regarding the footer 33, it has a shape
25 in which the footer 33 is easily interposed between
after-mentioned adjacent two lower-side rock suppression
walls 42. More specifically, like the footer 33 as shown
in Fig. 3B, the footer 33 could have a shape in which
a thickness in the arrow Y1Y2 direction of the footer
30 33 is narrower toward the arrow Z1 direction.

[0064] The plurality of membrane elements 3 as described above are accommodated in each of the accommodating sections 11A, 12A, 11B and 12B from the accommodation openings 16 so that the membrane elements 3 are arranged at predetermined intervals in the arrow Y1Y2 direction (in the axial direction of the tubular peripheral wall) in a posture in which the membrane elements 3 stand in the arrow Z1Z2 direction, then each membrane module 30 as shown in Figs. 5, 6A and 6B is formed.

10 [0065] In the membrane module 30 as shown in Figs. 5, 6A and 6B, the membrane elements 3 are arranged at predetermined intervals in the arrow Y1Y2 direction (in the axial direction of the tubular peripheral wall) with the filtration main bodies 31 of the membrane elements 15 3 facing each other (for instance, in a posture in which the membrane elements 3 stand in the arrow Z1Z2 direction as shown in Fig. 3).

[0066] As for the header 32 of the membrane element 3, the treated water lead-out portion 34 of the membrane 20 element 3 is connected to the connecting hole 23 of the tubular peripheral wall 21 (which will be described later using Fig. 4), then the header 32 is supported. Although the header 32 can be adequately supported by such connecting state in which the treated water lead-out 25 portion 34 and the connecting hole 23 are connected, as illustrated in Figs. 6A and 6B, the upper-side bridge portion 5 could be engaged with an end portion (an arrow X1 direction end portion in Fig. 3), located at an opposite side to the treated water lead-out portion 34, of the

header 32. With this engagement, a more stable supporting can be obtained.

[0067] With regard to the footer 33, both ends in the arrow X1X2 direction of the footer 33 are supported by the lower-side supporting portions 4 provided at the respective supporting frames 15.

[0068] <Supporting structure of lower-side supporting portion 4>

The lower-side supporting portion 4 shown in Figs. 5 and 6A has a lower-side base body 41 provided so as to extend in the arrow Y1Y2 direction along an upper end edge portion 15a of the supporting frame 15 and a plurality of lower-side rock suppression walls (or a plurality of lower-side wobble suppression walls) 42 provided at the lower-side base body 41 at positions arranged at predetermined intervals in the arrow Y1Y2 direction.

[0069] Each lower-side rock suppression wall 42 has a shape projecting in the arrow Z2 direction from the arrangement position at the lower-side base body 41. The lower-side rock suppression walls 42 are structured so that the membrane element 3 can be interposed between the adjacent two lower-side rock suppression walls 42.

[0070] According to the lower-side supporting portion 4 described above, it is possible to support each footer 33 so as to maintain the state in which the membrane elements 3 in the accommodated state are arranged at predetermined intervals in the arrow Y1Y2 direction. Further, according to the lower-side supporting portion 4 described above, when loading and unloading the membrane element 3 through the accommodation opening 16, the membrane

element 3 is guided by the adjacent two lower-side rock suppression walls 42, then the membrane element 3 can be easily moved in the arrow X1X2 direction.

[0071] By interposing the membrane element 3 between the
5 adjacent two lower-side rock suppression walls 42 as described above, for instance, when the membrane element 3 rocks (wobbles) in the arrow Y1Y2 direction due to operating conditions of the membrane filtration device 10, the rock (wobble) is suppressed by the two lower-side
10 rock suppression walls 42.

[0072] The lower-side rock suppression wall 42 is appropriately formed according to the number of the membrane elements 3 of the membrane module 30 and/or the shape of the membrane element 3. For instance, the
15 lower-side rock suppression walls 42 are arranged at predetermined intervals in the arrow Y1Y2 direction so that the membrane elements 3 in the accommodated state do not collide with each other.

[0073] A distance between the lower-side rock
20 suppression walls 42 could be set, for instance, so that a clearance (a gap) is formed between the membrane element 3 and the lower-side rock suppression wall 42 that is adjacent to the membrane element 3. In this case where the clearance is formed, it is possible to suppress a
25 frictional force that could be generated between the membrane element 3 and the lower-side rock suppression wall 42 adjacent to the membrane element 3. Therefore, good handling workability when loading and unloading the membrane element 3 can be obtained.

[0074] In the case of the lower-side supporting portions 4 shown in Figs. 5 and 6A, the lower-side supporting portions 4 support both end edge portions in the arrow X1X2 direction of each membrane element 3 in the accommodated state of the membrane module 30. Then, at an outside in the arrow X1X2 direction of each lower-side supporting portion 4, a lower-side shielding portion 43 is detachably provided so as to shield an arrow X1X2 direction outer side.

10 [0075] In a case of the lower-side shielding portion 43 shown in Fig. 5, the lower-side shielding portion 43 is supported by a supporting frame 44 that extends in the arrow Y1Y2 direction. By detachably fixing the supporting frame 44 to the frames 1c of the rack 1 (e.g. with fixing members (not shown)), the arrow X1X2 direction outer side of the lower-side supporting portion 4 is shielded.

[0076] By detachably providing the lower-side shielding portion 43 in this manner, an outward movement in the arrow X1X2 direction of the membrane element 3 in the accommodated state can be restrained.

[0077] <Supporting structure of upper-side bridge portion 5>

The upper-side bridge portion 5 shown in Figs. 6A and 6B has an upper-side base body 51 provided so as to extend in the arrow Y1Y2 direction (e.g. along the frame 1b) at the arrow Z2 direction side of the accommodation opening 16 of each of the accommodating sections 11A, 12A, 11B and 12B and a plurality of upper-side rock suppression walls (or a plurality of upper-side wobble suppression

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walls) 52 provided at the upper-side base body 51 at positions arranged at predetermined intervals in the arrow Y1Y2 direction.

[0078] Each upper-side rock suppression wall 52 has a shape projecting in the arrow Z1 direction from the arrangement position at the upper-side base body 51. The upper-side rock suppression walls 52 are structured so that the membrane element 3 can be interposed between the adjacent two upper-side rock suppression walls 52.

10 [0079] According to the upper-side bridge portion 5 described above, it is possible to support each header 32 so as to maintain the state in which the membrane elements 3 in the accommodated state are arranged at predetermined intervals in the arrow Y1Y2 direction. Further, 15 according to the upper-side bridge portion 5 described above, when loading and unloading the membrane element 3 through the accommodation opening 16, the membrane element 3 is guided by the adjacent two upper-side rock suppression walls 52, then the membrane element 3 can 20 be easily moved in the arrow X1X2 direction.

[0080] By interposing the membrane element 3 between the adjacent two upper-side rock suppression walls 52 as described above, for instance, when the membrane element 3 rocks (wobbles) in the arrow Y1Y2 direction due to the 25 operating conditions of the membrane filtration device 10, the rock (wobble) is suppressed by the two upper-side rock suppression walls 52.

[0081] The upper-side rock suppression wall 52 is appropriately formed according to the number of the 30 membrane elements 3 of the membrane module 30 and/or the

shape of the membrane element 3. For instance, the upper-side rock suppression walls 52 are arranged at predetermined intervals in the arrow Y1Y2 direction so that the membrane elements 3 in the accommodated state
5 do not collide with each other.

[0082] A distance between the upper-side rock suppression walls 52 could be set, for instance, so that a clearance (a gap) is formed between the membrane element 3 and the upper-side rock suppression wall 52 that is
10 adjacent to the membrane element 3. In this case where the clearance is formed, it is possible to suppress a frictional force that could be generated between the membrane element 3 and the upper-side rock suppression wall 52 adjacent to the membrane element 3. Therefore,
15 good handling workability when loading and unloading the membrane element 3 can be obtained.

[0083] In the case of the upper-side bridge portion 5 shown in Figs. 6A and 6B, the upper-side bridge portion 5 supports an arrow X1 direction one end edge portion,
20 located at an opposite side to the treated water lead-out portion 34, of the membrane element 3 in the accommodated state of the membrane module 30. Then, at an outer side in the arrow X1 direction of the upper-side bridge portion 5, an upper-side shielding portion 53 is detachably
25 provided so as to shield an arrow X1 direction outer side.

[0084] By detachably providing the upper-side shielding portion 53 in this manner, an outward movement in the arrow X1 direction of the membrane element 3 in the accommodated state can be restrained.

30 [0085] <Connecting structure>

In order to accommodate each membrane element 3 as shown in Fig. 5 and connect the connecting hole 23 of the tubular peripheral wall 21 and the treated water lead-out portion 34 of the membrane element 3, first, as shown in Fig. 4, the tubular peripheral wall 21 and the membrane element 3 are arranged so that the connecting hole 23 and the treated water lead-out portion 34 are close to each other while facing each other.

[0086] Then, by moving the tubular peripheral wall 21 and the membrane element 3 in a direction in which both of the tubular peripheral wall 21 and the membrane element 3 get closer to each other and fitting and inserting the treated water lead-out portion 34 into the connecting hole 23 from the liquid-tight portion 34a of the treated water lead-out portion 34, the connecting hole 23 and the treated water lead-out portion 34 can be liquid-tightly connected, then the treated water lead-out portion 34 can communicate with an inside of the tubular peripheral wall 21.

[0087] <Modification of connecting structure>
The connecting structure between the connecting hole 23 of the tubular peripheral wall 21 and the treated water lead-out portion 34 of the membrane element 3 is not limited to that shown in Fig. 4. For instance, the connecting structure can be changed as necessary according to the structure or configuration of the water collection pipes 2A and 2B and the membrane element 3.

[0088] For example, as shown in Fig. 7, a connecting structure in which thick portions 24 that are thicker in the arrow X1X2 direction (in the horizontal direction

among the radial direction of the tubular peripheral wall 21) are formed at a lower-side peripheral wall portion 25 located at the arrow Z1 direction side of the tubular peripheral wall 21 (at a lower side in the radial direction of the tubular peripheral wall), and the connecting holes 23 are appropriately provided at the thick portions 24 of the lower-side peripheral wall portion 25 could be possible.

[0089] In a case of this connecting structure as shown in Fig. 7, as compared with the connecting structure as shown in Fig. 4, a distance in the arrow Z1Z2 direction between an arrow Z1 direction side (a bottom side) of the inner peripheral surface 21a of the tubular peripheral wall 21 and an arrow Z1 direction side (a bottom side) of the connecting hole 23 is shortened. With this, it is possible to suppress generation of the so-called dead water region of the treated water flowing in the tubular peripheral wall 21.

[0090] Although the present invention has been described in detail only with respect to the embodiment described above, it is obvious to those skilled in the art that various modifications can be made within the scope of the technical idea of the present invention, and as a matter of course, such modifications belong to the scope of claims.

CLAIMS

1. A supporting structure comprising:
membrane modules formed by a plurality of membrane
elements arranged at predetermined intervals in
5 a horizontal direction, each of the membrane
elements having a filtration main body used for
membrane separation, a water collection portion
that collects treated water having undergone the
membrane separation from an upper end portion of
10 the filtration main body and a treated water
lead-out portion that leads out the treated water
coming from the water collection portion;
a rack having a shape in which the membrane modules
can be accommodated and having accommodating
15 sections into and from which each of the membrane
elements can be loaded and unloaded; and
a water collection pipe having a tubular peripheral
wall that extends in an arrangement direction of
the membrane elements accommodated in each
20 accommodating section and collecting the treated
water led out from the treated water lead-out
portions with the treated water lead-out portion
of each membrane element being connected to the
tubular peripheral wall, wherein
25 each accommodating section of the rack has
an accommodation opening which is open to one side
in a crossing direction crossing the
arrangement direction of the membrane elements
among the horizontal direction and through

which each membrane element can be loaded and unloaded in the crossing direction, and a pair of lower-side supporting portions extending in the arrangement direction of the membrane elements and arranged parallel to each other in the crossing direction, wherein each lower-side supporting portion has a lower-side base body extending in the arrangement direction of the membrane elements and supporting a lower end portion of each membrane element in the accommodated state, and a plurality of lower-side rock suppression walls provided at the lower-side base body at positions arranged at predetermined intervals in the arrangement direction of the membrane elements and having a shape projecting upward from respective arrangement positions of the lower-side rock suppression walls, and each membrane element in the accommodated state is interposed between adjacent two lower-side rock suppression walls.

2. The supporting structure as claimed in claim 1, wherein the lower-side rock suppression wall is provided so that a clearance is formed between the membrane element in the accommodated state and the

lower-side rock suppression wall adjacent to the
membrane element.

3. The supporting structure as claimed in claim 1 or
5 2, wherein
the lower-side supporting portions support both end
edge portions in the crossing direction of the
lower end portion of each membrane element in the
accommodated state, and
10 a lower-side shielding portion that shields an outer
side in the crossing direction of the lower-side
supporting portion is detachably provided at the
outer side in the crossing direction of at least
one of the lower-side supporting portions.
15
4. The supporting structure as claimed in any one of
the preceding claims 1 to 3, wherein
two accommodating sections of the rack are located
on opposite sides of the tubular peripheral wall
20 in a posture in which the two accommodating
sections face each other at their back surface
sides that are opposite sides to the respective
accommodation openings, and
the membrane module is accommodated in each
25 accommodating section.
5. The supporting structure as claimed in any one of
the preceding claims 1 to 4, wherein
each accommodating section of the rack further has
30 an upper-side bridge portion extending in the

arrangement direction of the membrane elements,
wherein

the upper-side bridge portion has

an upper-side base body extending in the
arrangement direction of the membrane
elements and engaged with the upper end
portion of each membrane element in the
accommodated state, and

a plurality of upper-side rock suppression
walls provided at the upper-side base body
at positions arranged at predetermined
intervals in the arrangement direction of the
membrane elements and having a shape
projecting downward from respective
arrangement positions of the upper-side rock
suppression walls, and

each membrane element in the accommodated state is
interposed between adjacent two upper-side rock
suppression walls.

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6. The supporting structure as claimed in claim 5,
wherein

the upper-side rock suppression wall is provided
so that a clearance is formed between the membrane
element in the accommodated state and the
upper-side rock suppression wall adjacent to the
membrane element.

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7. The supporting structure as claimed in any one of
the preceding claims 1 to 6, wherein

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the tubular peripheral wall has

at an upper side in a radial direction thereof,
a thick portion that is thicker in the crossing
direction among the radial direction of the
5 tubular peripheral wall, and

a connecting hole that penetrates the thick
portion in an inward-and-outward direction of
the tubular peripheral wall, and

the treated water lead-out portion is provided at
10 another side in the crossing direction of the water
collection portion, and connected to the
connecting hole in the accommodated state and
communicates with an inside of the tubular
peripheral wall.

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8. A membrane filtration device having the supporting
structure as claimed in any one of the preceding claims
1 to 7, wherein

the rack is provided, at a lower side of the
20 accommodating section, with an air diffuser
having a plurality of air blow holes.