DESCRIPTION

Title of Invention

WATER TREATMENT DEVICE AND METHOD OF INSTALLING SAME

Technical Field

[0001] The present invention relates to a water treatment device for producing treated water by filtrating water to be treated, and an installation method thereof.

Background Art

[0002] A water treatment device is conventionally known which produces treated water from raw water (water to be treated), such as river water, lake water, and groundwater, by using a filtration membrane. For example, a water treatment device including a filtration membrane is disclosed in Patent Literature 1. Generally, in this type of water treatment device, the design of whole layout, specification, and the like, of the device is performed according to the target performance, the site area, and the like, and when the facility is constructed, the materials, various components, and the like, are transported to the construction site, and are assembled together on the site, so as to form the complete water treatment device.

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2003-266071

Summary of Invention

Technical Problem

[0004] However, in the conventional water treatment device, since a large installation area is required, there has been a case where the water treatment device cannot be installed, and hence a compact water treatment device has been required. Further, it is necessary that various components, such as the filtration membrane and tanks, are stably installed on the ground, and that pipes are provided to connect the components to each other. Thus, the on-site workability is poor, and the time required for construction is increased, so that the work load is large. Further, there has been a problem that, when the water treatment device becomes unnecessary, the detaching work of the filtration membrane, the tanks, the pipes, and the like, is difficult and thereby the removing work of the water treatment device cannot be easily performed.

[0005] The present invention has been made in order to solve the above described problems. An object of the present invention is to provide a water treatment device which can be installed even in a limited space at a construction site and which can be easily installed and removed at the construction site, and also to provide an installation method of the water treatment device.

Solution to Problem

[0006] A water treatment device according to the present invention is a water treatment device which produces treated water by filtrating water to be treated, wherein, when the water to be treated, having electric conductivity of 250 μS/cm and turbidity of 30 NTU, is treated by a water treatment unit mounted on a transportable base and including a filtration membrane module and a reverse osmosis membrane module,

the electric conductivity of treated water treated is 10 μS/cm or less, and the amount of the treated water by the water treatment unit is 0.7 m^3/h or more per m^2 area of the base. Thereby, the treatment capacity for treated water per unit area can be significantly increased, as compared with a conventional single-bed type ion exchange resin column. Therefore, when the amount of treated water is the same, the water treatment device according to the present invention can be made more compact than the conventional device. Further, in the water treatment device according to the present invention, the area required to install the water treatment device is reduced as compared with the conventional water treatment device.

[0007] In the water treatment device according to the present invention, since the water treatment unit is mounted on the transportable base, the water treatment unit can be assembled in advance so as to be transported to a site. Thereby, the on-site workability can be improved, and the installing and removing work on the construction site can be easily performed. Thus, in addition to the effect that the installing and removing work can be easily performed, the water treatment device which has become unnecessary can be easily used for the other site, so that the applicability of the water treatment device can be improved. It is conventionally known to install a water treatment device on a transportable base. However, many of such water treatment devices are small in scale or are used for temporary installation. Thus, generally in large-scale and permanent use, a part or all of the water treatment device has been usually installed in a building. However, the water treatment device according to the present invention has a high

water treatment capacity per base area, while the device can be transported. Thus, a large-scale permanent water treatment device having a transportable base can be provided using a small number of transport bodies and without installing a building.

[0008] In the water treatment device according to the present invention, it is preferred that the treated water treated by the filtration membrane module is directly supplied to the reverse osmosis membrane module via a high pressure pump.

Conventionally, the pressure of the treated water treated by the filtration membrane module has been controlled by supplying the treated water to the reverse osmosis membrane module via an intermediate tank. However, in the water treatment device according to the present invention, the intermediate tank, and the like, is not provided between the filtration membrane module and the reverse osmosis membrane module. This configuration is effective in achieving space saving of the device and hence facilitates the miniaturization of the device as a whole as compared with the conventional ion exchange resin column, and the like.

[0009] Further, when the water treatment unit is housed in a transportable frame body, the leakage of noise to the outside can be prevented, and the damage to the water treatment unit caused by ultraviolet rays can also be prevented. Further, the countermeasure against rain and wind, and beauty in appearance of the device can be improved. Further, since the water treatment unit includes the filtration membrane module and the reverse osmosis membrane module, the water treatment unit can further improve the water quality of the

treated water as compared with, for example, the sand filtration, and the like, so that the water quality can be easily and stably maintained. Further, the clogging of the reverse osmosis membrane module can be suppressed by the filtration module, so that the stable operation can be achieved.

[0010] In the water treatment device according to the present invention, it is preferred that the water treatment unit include backwashing means for backwashing the filtration membrane module. In this case, the life of the filtration membrane module can be extended by periodically backwashing the filtration membrane module, so that the device can be stably operated for a long period of time.

[0011] In the water treatment device according to the present invention, it is preferred that the water treatment unit include high pressure air supply means for supplying compressed air for air scrubbing to the filtration membrane module. In this case, the life of the filtration membrane module can be extended by periodically air-washing the filtration membrane module, and thereby the device can be stably operated for a long period of time.

[0012] In the water treatment device according to the present invention, it is preferred that a work passage be provided in the transportable frame body. In this case, the maintenance can be easily performed during the operation of the device.

[0013] In the water treatment device according to the present invention, it is preferred that the filtration membrane module be installed in the transportable frame body so as to satisfy the condition of (the total length of the filtration membrane module)/ (the height inside the frame

body) = 90% or less. In this case, the filtration membrane module can be compactly installed in the frame body without bending the header pipe, so that the size of the water treatment device as a whole can also be reduced. Note that the filtration membrane module is preferably installed so as to satisfy a condition such that (the total length of the filtration membrane module)/ (the height inside the frame body) = 85% or less, and is more preferably installed so as to satisfy a condition such that (the total length of the filtration membrane module)/ (the height inside the frame body) = 80% or less.

[0014] In the water treatment device according to the present invention, it is preferred that the filtration membrane module be installed in the transportable frame body so as to be parallel to the height direction of the frame body, and that the reverse osmosis membrane module be installed in the transportable frame body so as to be perpendicular to the height direction of the frame body. In this case, the installation method enables the modules to be densely installed in the frame body while securing a work space in the frame body, and hence the installation method is most suitable for the miniaturization of the device.

[0015] In the water treatment device according to the present invention, it is preferred that a valve unit for the filtration membrane module and a valve unit for the reverse osmosis membrane module be both provided in the transportable frame body. In this case, the filtration membrane module and the reverse osmosis membrane module can be directly connected to each other via the high pressure pump within a limited space. Here, the valve unit of the filtration membrane module means a unit including valves for respectively switching the flow channels of,

for example, raw water, backwashing water, washing water, filtrated water, returned raw water, air, and wastewater, and/or valves for adjusting the flow rate of the fluids, and instruments for detecting the pressure, the flow rate, and the temperature of the fluids. The valve unit of the reverse osmosis membrane module means a unit including valves for respectively switching the flow channels of, for example, raw water, permeated water, concentrated water, and washing water, and/or valves for adjusting the flow rate of the fluids, and instruments for detecting the pressure and the flow rate of the fluids.

[0016] In the water treatment device according to the present invention, it is preferred that the filtration membrane module and/or the reverse osmosis membrane module be fixed by using the inner wall of the transportable frame body. In this case, a work space for replacement of the modules, inspection of fiber breakage, and the like, can be easily secured. Here, the "inner wall" includes the wall, the ceiling, and the floor inside the transportable frame body.

[0017] A water treatment device according to the present invention is a water treatment device which produces treated water by filtrating water to be treated, and preferably includes a water treatment unit including a filtration membrane module and a reverse osmosis membrane module so that treated water treated by the filtration membrane module is directly supplied to the reverse osmosis membrane module via a high pressure pump. Conventionally, the pressure of the treated water treated by the filtration membrane module is controlled by supplying the treated water to the reverse osmosis membrane module via an intermediate tank, and hence the size of the device as a whole is

increased. However, in the case where the treated water treated by the filtration membrane module is directly supplied to the reverse osmosis membrane module via the high pressure pump, the intermediate tank, and the like, is not provided between the filtration membrane module and the reverse osmosis membrane module. This configuration is effective in achieving space saving of the device and hence facilitates the miniaturization of the device as a whole as compared with the conventional ion exchange resin column, and the like.

[0018] In the water treatment device according to the present invention, it is preferred that the water treatment device further include: a supply pump for supplying water to be treated to the filtration membrane module; filtrated water flow rate measuring means for measuring the flow rate of the water filtrated by the filtration membrane module; pressure detecting means for detecting the suction pressure of the high pressure pump; permeated water flow rate measuring means for measuring the flow rate of the water permeated through the reverse osmosis membrane module; concentrated water amount adjusting means for adjusting the amount of water concentrated by the reverse osmosis membrane module; and a control unit for performing control of the water treatment unit, and that the control unit respectively perform control of the supply pump based on the result measured by the filtrated water flow rate measuring means, control of the high pressure pump based on the result detected by the pressure detecting means, and control of the concentrated water amount adjusting means based on the result measured by the permeated water flow rate measuring means. In this case, the stable operation of the device can be realized.

[0019] In the water treatment device according to the present invention, it is preferred that all of the fluid filtrated by the filtration membrane module be supplied to the reverse osmosis membrane module. In this case, the capacity for treating the treated water can be secured.

[0020] In an installation method of the water treatment device according to the present invention, after the water treatment unit including the filtration membrane module and the reverse osmosis membrane module is assembled in advance, the assembled water treatment unit is transported to a construction site and installed at the construction site. Thereby, the installation time of the water treatment device can be reduced, and the work on the site can be simplified, so that the on-site workability can be improved.

Advantageous Effects of Invention

[0021] According to the present invention, it is possible to provide a water treatment device which can be easily installed and removed at a construction site and to provide an installation method of the water treatment device.

Brief Description of Drawings

[0022] [Figure 1] Figure 1 is a perspective view showing a water treatment device according to a first embodiment.

[Figure 2] Figure 2 is a cross-sectional view along line II-II in Figure 1.

[Figure 3] Figure 3 is a cross-sectional view along line III-III in Figure 1.

[Figure 4] Figure 4 is a cross-sectional view along line IV-IV in Figure 1.

[Figure 5] Figure 5 is a schematic view for explaining a flow of treatment in a water treatment facility using the water treatment device.

[Figure 6] Figure 6 is an outlined schematic view showing the control of the water treatment unit.

[Figure 7] Figure 7 is a perspective view showing a state where the water treatment device is transported.

[Figure 8] Figure 8 is an exploded perspective view showing a water treatment device according to a second embodiment.

[Figure 9] Figure 9 is a perspective view showing a state where the door is opened.

[Figure 10] Figure 10 is a perspective view showing a water treatment device according to a third embodiment.

[Figure 11] Figure 11 is an outlined schematic view showing the control of the water treatment unit.

Description of Embodiments

[0023] In the following, preferred embodiments of the water treatment device according to the present invention will be described in detail with reference to the accompanying drawings. Note that, in the description, the same components are denoted by the same reference numerals, and the duplicate explanation thereof is omitted.

[0024] (First embodiment)

Figure 1 is a perspective view showing a water treatment device according to a first embodiment, and Figure 2 is a cross-sectional view along line II-II in Figure 1. Figure 3 is a cross-sectional view along line III-III in Figure 1, and Figure 4 is a cross-sectional view along line IV-IV in Figure 1. A water treatment device 1 according to the present

embodiment produces treated water by filtrating water to be treated (for example, industrial water, industrial wastewater, river water, and the like), and includes a container (frame body) 2 and a water treatment unit 3 housed in the container 2.

[0025] The container 2 is a box-like marine container usually used for freight transportation and is configured by a plate-like base 4 arranged at the bottom portion of the container 2, and a cover portion 5 attached to the base 4. The base 4 is configured to be transportable. A door 6 is provided at one longitudinal end of the cover portion 5. It is possible to adopt one of the forms in which the total length of the container 2 is about 6 m (20 feet) and about 12 m (40 feet), respectively.

[0026] The water treatment unit 3 is mounted on the base 4, and is configured mainly by a microfiltration membrane (hereinafter referred to as MF membrane) unit 7 and a reverse osmosis membrane (hereinafter referred to as RO membrane) unit 8. The MF membrane unit 7 is configured by aligning twenty MF membrane modules 9 in ten rows along the longitudinal direction of the container 2. Each of the MF membrane modules 9 is formed in a cylindrical shape, and is vertically provided between upper and lower header pipes. Each of the MF membrane modules 9 is connected to each of the upstream header pipe and the downstream header pipe via branch pipes.

[0027] The RO membrane unit 8 is configured by aligning fourteen RO membrane modules 10 in seven rows along the height direction of the container 2. Each of the RO membrane modules 10 is formed in a cylindrical shape, and is attached to an attachment base 11 so as to be parallel to the base 4 (see Figure 3 and Figure 4). Each of the RO

membrane modules 10 is connected to each of the upstream header pipe and the downstream header pipe. Each of the MF membrane modules 9 of the MF membrane unit 7 and each of the RO membrane modules 10 of the RO membrane unit 8 are directly communicated with each other by a pipe 14.

[0028] On the depth side of the container 2, an RO fluid supply pump 12 for supplying treated water to the RO membrane unit 8, and a backwash chamber (backwashing means) 13 for supplying backwash fluid to the MF membrane unit 7 are provided. The RO fluid supply pump (high pressure pump) 12 is arranged in the middle of the pipe 14, and supplies the first treated water treated by the MF membrane unit 7 directly to the RO membrane unit 8 at a high pressure.

[0029] The backwash chamber 13 is arranged above the pipe 14 and is communicated with the pipe 14. Therefore, a part of the first treated water, which is treated by the MF membrane unit 7 and flows through the pipe 14, flows into the backwash chamber 13 so as to be stored in the backwash chamber 13. The first treated water stored in the backwash chamber 13 is used when the MF membrane unit 7 is backwashed. Further, below the pipe 14 between the backwash chamber 13 and the MF membrane unit 7, an operation panel 15 for controlling the water treatment device 1 is arranged.

[0030] On the side of the door 6 of the container 2, an NaOH storage tank 16, a scale inhibitor storage tank 17, an SBS storage tank 18, and an NaClO storage tank (backwashing means) 19 are aligned. Fluid supply pumps 20, 21, 22 and 23 are connected to these storage tanks, respectively. The NaOH storage tank 16, the scale inhibitor storage

tank 17, the SBS storage tank 18, and the NaClO storage tank 19 are provided on a support base 24. Inside the support base 24, an MF fluid supply pump 25 for supplying water to be treated to the MF membrane unit 7 is arranged.

[0031] In the following, a flow of treatment in a water treatment facility using the water treatment device 1 will be described with reference to Figure 5. Figure 5 is a schematic view for explaining the flow of treatment in the water treatment facility using the water treatment device. Note that, in Figure 5, the region surrounded by the two-dot chain line corresponds to the water treatment device 1 according to the present embodiment.

[0032] As shown in Figure 5, in the water treatment device 1 according to the present embodiment, the MF membrane unit 7 and the RO membrane unit 8 are directly connected to each other by the pipe 14 without via an intermediate tank, and the like. Further, the first treated water treated in the MF membrane unit 7 is directly supplied to the RO membrane unit 8 by the RO fluid supply pump 12.

[0033] The NaClO storage tank 19 is communicated with the pipe 14 via a supply pipe (backwashing means) 26. The NaClO solution stored in the NaClO storage tank 19 is used when the MF membrane module 9 is backwashed. Further, the reducing agent storage tank 18 for storing a reducing agent, such as SBS (sodium bisulfite), is communicated with the pipe 14 via a supply pipe 27, and the scale inhibitor storage tank 17 is communicated with the pipe 14 via a supply pipe 28. The SBS and the scale inhibitor which are stored in these storage tanks are used when the RO membrane module 10 is washed.

The washing wastewater of the RO membrane module 10 is discharged to the outside together with the backwash wastewater of the MF membrane module 9.

[0034] A high pressure air supply pipe (high pressure air supply means) 29 is communicated with the bottom portion of the MF membrane unit 7. The high pressure air supply pipe 29 supplies compressed air for air scrubbing to the MF membrane module 9. A high pressure air supply pipe (backwashing means) 30 is communicated with the top portion of the backwash chamber 13. The high pressure air supply pipe 30 has a function of, when the MF membrane module 9 is backwashed, supplying high pressure air to the backwash chamber 13, so as to push out the first treated water stored in the backwash chamber 13 to the side of the MF membrane module 9.

[0035] As shown in Figure 5, a raw water tank 31, an activated carbon pretreatment column 32, and a storage tank 33 are provided as equipment relating to the pretreatment of the water treatment device 1. The raw water tank 31 is a tank for temporarily storing raw water (water to be treated), such as industrial water, industrial wastewater, and river water. In the raw water tank 31, refuse and the like in the raw water is precipitated and separated. After the precipitation and separation in the raw water tank 31, impurities, and the like, of the raw water is further removed in the activated carbon pretreatment column 32, and then the raw water is stored as pretreated water (water to be treated) in the storage tank 33. Then, the pretreated water in the storage tank 33 is supplied to the MF membrane unit 7 by the MF fluid supply pump 25.

[0036] On the other hand, a storage tank 34, an ion exchange resin

column 35, and a pure water storage tank 36 are provided as equipment relating to the post-treatment of the water treatment device 1. The second treated water treated by the RO membrane unit 8 is temporarily stored in the storage tank 34. The second treated water is further subjected to the ion exchange treatment by the ion exchange resin column 35 and is then made to flow into the pure water storage tank 36.

[0037] Figure 6 is an outlined schematic view showing the control of the water treatment unit. As shown in Figure 6, a flow meter 48 for measuring the flow rate of the first treated water flowing through the pipe 14, and a pressure sensor 49 for detecting the pressure of the first treated water are provided between the MF membrane unit 7 and the RO fluid supply pump 12. The flow meter 48 and the pressure sensor 49 are connected to a control CPU (Central Processing Unit) 52 provided in the operation panel 15, and transmit each piece of measured data to the control CPU 52.

[0038] Further, a flow meter 50 for measuring the flow rate of the second treated water flowing from the RO membrane unit 8, and an adjusting valve 51 for adjusting the flow rate of the second treated water are provided between the RO membrane unit 8 and the storage tank 34. The flow meter 50 is connected to the control CPU 52 and transmits the measured data to the control CPU 52. Each of the MF fluid supply pump 25, the RO fluid supply pump 12, and the adjusting valve 51 is connected to the control CPU 52 and receives the control signal of the control CPU 52, so as to perform each operation.

[0039] The control CPU 52 performs, on the basis of the data measured by the flow meter 48, constant flow rate control of the MF fluid supply

pump 25, and performs, on the basis of the data detected by the pressure sensor 49, control of the RO fluid supply pump 12 so that the pressure on the suction side of the RO fluid supply pump 12 becomes positive (+). Further, the control CPU 52 performs, on the basis of the data measured by the flow meter 50, control of the adjusting valve 51 so that the flow rate of the second treated water becomes constant.

[0040] In the water treatment device 1 configured in this way, when the water to be treated, before being treated by the water treatment unit 3 (that is, pretreated water supplied, by the MF fluid supply pump 25, to each of the MF membrane modules 9 of the MF membrane unit 7), has electric conductivity of 250 μS/cm and turbidity of 30 NTU, the electric conductivity of the treated water treated by the water treatment unit 3 (that is, the second treated water after being filtrated by each of the RO membrane modules 10 of the RO membrane unit 8) is 10 μS/cm or less. Further, the amount of the treated water treated by the water treatment unit 3 is 0.7 m^3/h or more per m^2 area of the base 4, and preferably 1.4 m^3/h or more. For example, from the viewpoint of the workability and the ease of maintenance on the transportable base 4, the amount of the treated water treated by the water treatment unit 3 is preferably 5.0 m^3/h or less, and more preferably 4.0 m^3/h or less.

[0041] Thereby, the treatment capacity for treated water per unit area can be significantly increased, as compared with a conventional single-bed type ion exchange resin column. Therefore, when the amount of treated water is the same, the device can be made more compact than the conventional device. Further, the MF membrane modules 9 and the RO membrane modules 10 can be mounted on the

base 4 more densely as compared with the conventional single-bed type ion exchange resin column, and hence the water treatment device 1 can be installed even in a narrow site in which the conventional water treatment device cannot be installed.

[0042] Note that the treatment capacity, and the like, of the water treatment unit 3 according to the present embodiment is not limited to the above-described numerical values. For example, the electric conductivity of the treated water is changed by the change of the electric conductivity of the water to be treated. However, with the water treatment unit 3 according to the present embodiment, treated water having stable electric conductivity can be obtained even when the electric conductivity of water to be treated is changed. For example, even when the electric conductivity of raw water is changed from 100 to 1000 μS/cm, it is possible to produce low-level pure water having electric conductivity of 50 μS/cm or less and a rate of 0.5m^3/h or more.

[0043] With the water treatment device 1 according to the present embodiment, since the water treatment unit 3 is mounted on the transportable base 4, the water treatment unit 3, after being assembled in a factory, can be transported to a site by transportation means, such as a track T, as shown in Figure 7, and can be installed at the construction site. Thereby, the installation time of the water treatment device 1 can be reduced. Also, the work at the site can be simplified, and the workability at the site can be improved, so that the installation work at the construction site can be easily performed. Further, the removing work of the water treatment device 1 can also be easily performed. In addition to the effect that the installing work and the removing work can

be easily performed in this way, the water treatment device 1 which has become unnecessary at the site can be easily used at another site, and hence the applicability of the water treatment device 1 can be improved.

It is conventionally known to install a water treatment device on a transportable base. However, many of such water treatment devices are small in scale or are used for temporary installation. Thus, generally, in large-scale and permanent use, a part or all of the water treatment device has been usually installed in a building. However, the water treatment device 1 according to the present embodiment has a high water treatment capacity per area of the base 4, while the device can be transported. Thus, a large-scale permanent water treatment device having a transportable base can be provided using a small number of transport bodies and without installing a building.

[0044] Further, the water treatment unit 3 mounted on the base 4 is covered by the cover portion 5, the leakage of noise to the outside can be prevented, and the damage to the water treatment unit 3 caused by ultraviolet rays can also be prevented. Further, the countermeasure against rain and wind, and beauty in appearance of the device can be improved.

[0045] Further, since the water treatment unit 3 includes the MF membrane module 9 and the RO membrane module 10, the water treatment unit 3 can further improve the water quality of the treated water as compared with, for example, the sand filtration, and the like, so that the water quality can be easily and stably maintained. Further, the clogging of the RO membrane module 10 can be suppressed by the MF membrane module 9, so that the stable operation can be achieved.

[0046] Further, the treated water treated by the MF membrane module 9 is directly supplied to the RO membrane module 10 via the RO fluid supply pump 12. Thus, as compared with the conventional type in which an intermediate tank is provided between the MF membrane module 9 and the RO membrane module 10, this configuration, in which the intermediate tank is eliminated, is effective in achieving space saving of the device and hence facilitates the miniaturization of the device as a whole.

[0047] Further, the backwashing means which is configured by the backwash chamber 13 for backwashing the MF membrane module 9, the high pressure air supply pipe 30, the NaClO storage tank 19, and the like, and the high pressure air supply pipe 29 which supplies the compressed air for air scrubbing to the MF membrane module 9 are provided. Thus, the life of the MF membrane module 9 can be extended by periodically backwashing or air-washing the MF membrane module 9, and thereby the water treatment device 1 can be stably operated for a long period of time.

[0048] (Second embodiment)

In the following, a second embodiment will be described with reference to Figure 8. A water treatment device 37 according to the present embodiment is different from the first embodiment in that a cover portion 40 of a container (frame body) 38 is detachably provided on a base 39. The other components are the same as those of the first embodiment, and therefore the duplicate explanation thereof is omitted.

[0049] Specifically, unlike the container 2 usually used for freight transportation, the box-like container 38 is configured by the

transportable base 39, and the cover portion 40 which is detachably attached to the base 39. The base 39 is formed in a rectangular shape, and is provided, at each of its four corners, with a projecting portion 44 projecting outward from the main body of the base 39. A through hole 46 extending in the thickness direction of the projecting portion 44 is formed at the center of each of the projecting portions 44.

[0050] The cover portion 40 includes a housing 41 surrounding the water treatment unit 3, and a door (movable wall portion) 42 which can open and close the opening formed in the side wall of the housing 41. A projecting portion 43 projecting outward from the housing 41 is provided at each of the four corners of the cover portion 40. The position of each of the projecting portions 43 corresponds to the position of each of the projecting portions 44 of the base 39. At the center of each of the projecting portions 43, a through hole 47 is formed in correspondence with the through hole 46 of each of the projecting portions 44.

[0051] When the water treatment device 37 is manufactured, the water treatment unit 3 is first assembled by installing such components as the MF membrane unit 7 and the RO membrane unit 8 on the base 39. After the water treatment unit 3 is assembled, the cover portion 40 is set to cover the water treatment unit 3. Then, after the alignment between the through hole 47 of the projecting portion 43, and the through hole 46 of the projecting portion 44 is performed, a bolt 45 is inserted into each pair of the through holes 46 and 47 so that the base 39 and the cover portion 40 are fixed to each other by the bolts 45.

[0052] With the water treatment device 37 according to the present

embodiment, the same operation effect as that of the water treatment device 1 according to the first embodiment can be obtained, and also the water treatment device 37 can be easily manufactured in such a manner that, after the water treatment unit 3 is assembled on the base 39, the cover portion 40 is set to cover the water treatment unit 3 and is then attached to the base 39. Further, the cover portion 40 is detachably attached to the base 39, and hence, for example, the maintenance work of the water treatment unit 3 as a whole or the component replacement work of the water treatment unit 3 can be easily performed by removing the cover portion 40. Further, in the case where the water treatment device 37 has become unnecessary, since the cover portion 40 is easily detached from the base 39 by removing the bolts 45, the disassembling work and the removing work of the water treatment unit 3 can be easily performed.

[0053] Further, since the door 42 is formed in the side wall of the housing 41, for example, when the MF membrane module 9 incorporated into the MF membrane unit 7 is inspected or replaced, a worker, and the like, can easily enter the inside of the container 38 by opening the door 42 as shown in Figure 9, and hence the inspection work and the replacement work of the MF membrane module 9 can be easily performed. As a result, the maintainability of the water treatment device 1 can be improved.

[0054] (Third embodiment)

In the following, a third embodiment will be described with reference to Figure 10. A water treatment device 53 according to the present embodiment is different from the first embodiment in that the

water treatment device 53 is not housed in the container but is mounted on a transportable base 54. The other components are the same as those of the first embodiment, and therefore the duplicate explanation thereof is omitted.

[0055] That is, the water treatment device 53 includes the water treatment unit 3 and is mounted on the plate-like base 54. The water treatment unit 3 is configured mainly by the MF membrane unit 7 and the RO membrane unit 8. Further, the first treated water treated by the MF membrane unit 7 is directly supplied to the RO membrane unit 8 by the RO fluid supply pump 12.

[0056] Conventionally, the pressure of the treated water treated by the filtration membrane module is controlled by supplying the treated water to the reverse osmosis membrane module via an intermediate tank, and hence the size of the device as a whole is increased. However, in the water treatment device 53 according to the present embodiment, the first treated water treated by the MF membrane unit 7 is directly supplied to the RO membrane unit 8 via the RO fluid supply pump 12, and hence the intermediate tank, and the like, is not provided between the MF membrane unit 7 and the RO membrane unit 8. This configuration is effective in achieving space saving of the device and hence facilitates the miniaturization of the device as a whole as compared with the conventional ion exchange resin column, and the like.

[0057] Figure 11 is an outlined schematic view showing the control of the water treatment unit. As shown in Figure 11, a flow meter (filtrated water flow rate measuring means) 48 for measuring the flow rate of the first treated water flowing through the pipe 14, and a pressure

sensor (pressure detecting means) 49 for detecting the pressure on the suction side of the RO fluid supply pump 12 are provided between the MF membrane unit 7 and the RO fluid supply pump 12. The flow meter 48 and the pressure sensor 49 are connected to the control CPU 52 installed in the operation panel 15, and transmit the measured data to the control CPU 52, respectively.

[0058] Further, an RO permeated water flow meter (permeated water flow rate measuring means) 56 for measuring the flow rate of the permeated water (second treated water) flowing from the RO membrane unit 8 is provided on the downstream side of the RO membrane unit 8. Further, an RO concentrated water amount adjusting valve (concentrated water amount adjusting means) 55 for adjusting the amount of RO concentrated water is directly connected to the RO membrane unit 8. The RO permeated water flow meter 56 is connected to the control CPU 52, and transmits the measured data to the control CPU 52. Each of the MF fluid supply pump 25, the RO fluid supply pump 12, and the RO concentrated water amount adjusting valve 55 is connected to the control CPU 52, and receives a control signal of the control CPU 52 to perform each operation based on the control signal.

[0059] In the water treatment device 53 configured in this way, an MF-RO direct connection control, such as flow rate control, pressure control, and flow rate control, is performed. Specifically, the flow meter 48 first measures the flow rate of the MF filtrated water (first treated water), and outputs the signal of the measured flow rate to the control CPU 52. The control CPU 52 performs a PID (Proportional

Integral Derivative) operation on the basis of the data measured by the flow meter 48, and outputs the operation result. Note that the examples of the PID operation include, for example, an output operation based on the deviation between the measured data and the set value. Subsequently, the control CPU 52 controls the frequency of the inverter for the MF fluid supply pump 25 on the basis of the output of the PID operation. Thereby, the number of revolutions of the motor of the MF fluid supply pump 25 is controlled, so that the supply amount to the MF membrane unit 7 is changed.

[0060] The pressure sensor 49 detects the pressure on the suction side of the RO fluid supply pump 12, and outputs the pressure signal to the control CPU 52. The control CPU 52 performs the PID operation on the basis of the pressure signal on the suction side of the RO fluid supply pump 12, and outputs the operation result. Subsequently, the control CPU 52 controls the frequency of the inverter for the RO fluid supply pump 12 on the basis of the output of the PID operation. Thereby, the number of revolutions of the motor of the RO fluid supply pump 12 is controlled, so that the discharge amount of the RO fluid supply pump 12 is changed.

[0061] The RO permeated water flow meter 56 measures the flow rate of RO permeated water and outputs the measured signal to the control CPU 52. The control CPU 52 performs the PID operation on the basis of the RO permeated water flow rate signal, and outputs the operation result. Subsequently, the control CPU 52 controls the RO concentrated water amount adjusting valve 55 on the basis of the output of the PID operation. Therefore, the amount of RO concentrated water is

changed. Thereby, the amount of RO permeated water is changed.

[0062] For example, when the set value of the amount of MF filtrated water is 25 m^3/h, and when the set value of the suction pressure of the RO fluid supply pump 12 is 5 m water column, the discharge amount of the RO fluid supply pump 12 is 25 m^3/h. Further, when the set value of the amount of RO permeated water is set to 20 m^3/h, the amount of RO concentrated water is 5 m^3/h, so that a balance is effected.

[0063] When the suction pressure of the RO fluid supply pump 12 is stabilized at the set value of 5 m water column, the pushing flow rate from the MF membrane unit 7 is balanced with the suction flow rate of the RO fluid supply pump 12. In this case, the discharge amount of the RO fluid supply pump 12 is 25 m^3/h, and this amount is the same as the supply amount to the MF membrane unit 7. Then, the RO concentrated water amount adjusting valve 55 is operated, so that the discharge amount of the RO fluid supply pump 12 is distributed into the amount of RO permeated water of 20 m^3/h and the amount of RO concentrated water of 5 m^3/h.

[0064] Further, when the differential pressure of the MF membrane is increased, the number of revolutions of the MF fluid supply pump 25 is increased so that the MF filtrated water amount of 25 m^3/h, which is the set value, is maintained. When the differential pressure of the RO membrane is increased, the number of revolutions of the RO fluid supply pump 12 is increased so that the RO permeated water amount of 20 m^3/h (RO concentrated water amount of 5 m^3/h), which is the set value, is maintained. Therefore, the suction pressure set value of 5 m water column of the RO fluid supply pump 12 (that is, the state where

the pushing flow rate is balanced with the suction flow rate of the RO fluid supply pump 12) is continuously stabilized. Thereby, the stable operation of the water treatment device 53 can be realized.

[0065] The above-described embodiments describe examples of the water treatment device according to the present invention, and the water treatment device according to the present invention is not limited to the above-described embodiments. The water treatment device according to the present invention may be a device obtained by modifying the water treatment device according to the embodiments within the scope described in the claims or a device obtained by applying the water treatment device according to the embodiments to the other device.

[0066] For example, in the above-described embodiment, the RO membrane unit 8 is formed as one stage type, but may also be formed as two stage type or three stage type in which the concentrated water of the preceding stage, or the permeated water of the preceding stage is used as raw water, as required. Further, the door 42 is provided as a movable wall portion which can open and close the opening formed in the housing 41, but a shutter may also be provided. Further, besides the microfiltration membrane, an ultrafiltration membrane is also applied as the filtration membrane.

[0067] In the following, the present invention will be described more specifically on the basis of examples, but the present invention is not limited to the following examples.

[0068] (Example 1)

In the present example, a water treatment device having the same configuration as that of the first embodiment was prepared, and

the amount of water treated by the water treatment unit per m^2 area was measured. The size of the container was 20 feet, the installation area of the container was 15 m^2 (6 m × 2.5 m), and the capacity of the container was 10.5 m^3/h. As a result of measurement, the amount of water treated by the water treatment unit per m^2 area was 0.7 m^3/h or more.

[0069] (Example 2)

In the present example, a water treatment device having the same configuration as that of the first embodiment was prepared, and the amount of water treated by the water treatment unit per m^2 area was measured. The size of the container was 20 feet, the installation area of the container was 15 m^2 (6 m × 2.5 m), and the capacity of the container was 20 m^3/h. As a result of measurement, the amount of water treated by the water treatment unit per m^2 area was 1.3 m^3/h.

[0070] (Example 3)

In the present example, a water treatment device having the same configuration as that of the first embodiment was prepared, and the amount of water treated by the water treatment unit per m^2 base area was measured. In the water treatment device according to this example, the chemical solution tank and the chemical solution pump were not included as compared with example 2. Further, the size of the container was 20 feet, the number of containers was three, the installation area of the container was 45 m^2 (6 m × 2.5 m × 3), and the capacity of the container (RO1 output) was 72m^3/h. As a result of measurement, the amount of water treated by the water treatment unit per m^2 area was 1.6 m^3/h.

[0071] (Comparison example)

Further, a conventional building type water treatment device was prepared, and the amount of water treated by the water treatment unit per m^2 area was measured, so as to be compared with the amount of water treated by the water treatment device according to the present invention. In the case of the building type water treatment device, the RO1 supply tank (that is, intermediate tank) and the backwash pump are installed, and hence the installation area is large. The amount of MF filtrated water was 28.6 m^3/h, the volume of the RO1 supply tank was 28.6 m^3, the retention time in the tank was 60 minutes, the diameter of the RO1 supply tank was 3.5 m, and the RO1 treatment capacity was 20 m^3/h. Further, the installation area of the RO1 supply tank was 16 m^2 (4 m × 4 m), the installation area of the backwash pump was 0.6 m^2 (0.8 m × 0.7 m), and the installation area of the water treatment device was 15 m^2 (6 m × 2.5 m). As a result of measurement, the amount of water treated by the water treatment unit per m^2 area was 0.6 m^3/h.

[0072] From the above, it was confirmed that the amount of treated water per m^2 area in the conventional building type water treatment device is 0.6 m^3/h, and that the amount of treated water per m^2 area in the water treatment device according to the present invention is 0.7 m^3/h or more.

Reference Signs List

[0073] 1, 37, 53 water treatment device

2, 38 container (frame body)

3 water treatment unit

4, 39 base

5, 40 cover portion

9 MF membrane module

10 RO membrane module

12 RO fluid supply pump (high pressure pump)

13 backwash chamber (backwashing means)

19 NaClO storage tank (backwashing means)

25 MF fluid supply pump

26 supply pipe (backwashing means)

29 high pressure air supply pipe (high pressure air supply means)

30 high pressure air supply pipe (backwashing means)

41 housing

42 door (movable wall portion).

CLAIMS

1. A water treatment device for producing treated water by filtrating water to be treated,

wherein, when the water to be treated, having electric conductivity of 250 μS/cm and turbidity of 30 NTU, is treated by a water treatment unit mounted on a transportable base and including a filtration membrane module and a reverse osmosis membrane module, the electric conductivity of treated water is 10 μS/cm or less, and the amount of the treated water treated by the water treatment unit is 0.7 m^3/h or more per m^2 area of the base.

2. The water treatment device according to claim 1, wherein the treated water treated by the filtration membrane module is directly supplied to the reverse osmosis membrane module via a high pressure pump.

3 The water treatment device according to claim 1 or claim 2, wherein the water treatment unit includes backwashing means for backwashing the filtration membrane module.

4. The water treatment device according to any one of claim 1 to claim 3, wherein the water treatment unit includes high pressure air supply means for supplying compressed air for air scrubbing to the filtration membrane module.

5. The water treatment device according to any one of claim 1 to claim 4, wherein the water treatment unit is housed in a transportable frame body.

6. The water treatment device according to claim 5, wherein a work passage is provided in the transportable frame body.

7. The water treatment device according to claim 5 or claim 6, wherein the filtration membrane module is installed in the transportable frame body so as to satisfy a condition such that (the total length of the filtration membrane module)/ (the height inside the frame body) = 90% or less.

8. The water treatment device according to any one of claim 5 to claim 7, wherein the filtration membrane module is installed in the transportable frame body so as to be parallel to the height direction of the frame body, and the reverse osmosis membrane module is installed in the transportable frame body so as to be perpendicular to the height direction of the frame body.

9. The water treatment device according to any one of claim 5 to claim 8, wherein a valve unit of the filtration membrane module and a valve unit of the reverse osmosis membrane module are both provided in the transportable frame body.

10. The water treatment device according to any one of claim 5 to claim 9, wherein the filtration membrane module and/or the reverse osmosis membrane module are fixed by using the inner wall of the transportable frame body.

11. A water treatment device for producing treated water by filtrating water to be treated, the water treatment device comprising

a water treatment unit including a filtration membrane module and a reverse osmosis membrane module,

wherein treated water treated by the filtration membrane module is directly supplied to the reverse osmosis membrane module via a high pressure pump.

12. The water treatment device according to any one of claim 1 to claim 11, further comprising:

a supply pump for supplying water to be treated to the filtration membrane module;

filtrated water flow rate measuring means for measuring the flow rate of water filtrated by the filtration membrane module;

pressure detecting means for detecting the suction pressure of the high pressure pump;

permeated water flow rate measuring means for measuring the flow rate of water permeated through the reverse osmosis membrane module;

concentrated water amount adjusting means for adjusting the amount of water concentrated by the reverse osmosis membrane module; and

a control unit for performing control of the water treatment unit,

wherein the control unit respectively performs control of the supply pump based on the result measured by the filtrated water flow rate measuring means, control of the high pressure pump based on the result detected by the pressure detecting means, and control of the concentrated water amount adjusting means based on the result measured by the permeated water flow rate measuring means.

13. The water treatment device according to any one of claim 1 to claim 12, wherein all the fluid filtrated by the filtration membrane module is supplied to the reverse osmosis membrane module.

14. An installation method of a water treatment device wherein, after the water treatment device according to any one of claim 1 to

claim 10 is assembled in advance, the assembled water treatment device is transported to a construction site and installed at the construction site.