

DESCRIPTION

DEVICE FOR CLEANING AND METHOD FOR CLEANING WATER TREATMENT
MEMBRANE, AND WATER TREATMENT SYSTEM

5 TECHNICAL FIELD

[0001] The present invention relates to a cleaning device
and a cleaning method for a water treatment membrane through
which organic substances contained in waste water or the like
are subjected to membrane separation, and a water treatment
10 system.

BACKGROUND ART

[0002] One example of methods for removing organic
substances from service water, sewage, waste water such as
15 industrial waste water, or the like containing organic
substances is membrane separation using a water treatment
membrane. In such a water treatment system, raw water such
as waste water is filtered by a water treatment membrane so
that the raw water is separated into organic substances and
20 filtered water. Thus, removal of organic substances can be
stably performed. However, as the treatment is performed
successively, organic substances are adhered to the inside
and the surface of the water treatment membrane, so that
pores formed in the water treatment membrane may be clogged.
25 When the pores of the water treatment membrane are clogged,

the transmembrane pressure increases or the amount of filtered water is reduced, so that the treatment capacity decreases. Therefore, it is necessary to regularly clean the inside and the surface of the water treatment membrane, to
5 remove organic substances. As a method for cleaning the water treatment membrane, reverse cleaning is generally performed in which cleaning liquid is caused to flow from the filtering secondary side (filtered water side) to the filtering primary side (raw water side) of the water
10 treatment membrane, thereby cleaning the inside and the membrane surface of the water treatment membrane. Various cleaning liquids are used for the reverse cleaning, for example, water or an oxidizing agent aqueous solution such as sodium hypochlorite aqueous solution is used. In order to
15 obtain a higher cleaning effect, ozone water having high oxidizing power may be used.

[0003] In the case of using ozone water as a cleaning liquid, even if ozone water in which ozone is dissolved to an extent close to saturation solubility is attempted to be used
20 in order to obtain a sufficient cleaning effect, the dissolved ozone might be isolated due to a negative pressure that occurs partially inside a pump for pressure-feeding the ozone water. Thus, there is a possibility that the ozone concentration in the cleaning liquid decreases and a
25 sufficient cleaning effect is not obtained. In addition, in

the case of using a general centrifugal pump, there is a possibility that the performance of the pump is reduced due to cavitation occurring in the pump or the pump becomes unable to operate due to sucking of the isolated ozone gas.

5 [0004] Accordingly, proposed is a cleaning method in which air bubbling is performed for introducing bubbles of ozone gas or the like to the raw water side, at the same time as reverse cleaning using ozone containing water, in order to enhance the cleaning effect (see, for example, Patent
10 Document 1).

In another method, cleaning gas such as ozone gas generated by a gas generator is mixed with a fluid such as water by an ejector (Venturi-type gas-liquid mixing device), to generate a cleaning fluid, and the cleaning fluid is
15 introduced into a water cleaning tank provided with a water treatment membrane (hollow fiber filter), not via a pump (see, for example, Patent Document 2).

In still another method, by a uniaxial eccentric screw pump, water in which bubbles of ozone gas are suspended
20 is pushed and introduced into a pressure ozone dissolution tank that also serves as an accumulator (see, for example, Patent Document 3).

CITATION LIST

25 PATENT DOCUMENT

[0005] Patent Document 1: Japanese Laid-Open Patent
Publication No. 2001-79365 (paragraph [0006] of the
specification, FIG. 1)

Patent Document 2: Japanese Laid-Open Patent
5 Publication No. 2012-96209 (paragraphs [0022] to [0027] of
the specification, FIG. 1 to FIG. 5)

Patent Document 3: Japanese Laid-Open Patent
Publication No. 06-64904 (paragraphs [0014] and [0015] of the
specification, FIG. 1)

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SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006] However, for the method described in Patent
Document 1, it is necessary to separately provide a
15 compressor for air bubbling, and the like, resulting in a
complicated structure and increase in cost.

In the method described in Patent Document 2,
reverse cleaning for the water treatment membrane is
performed using the cleaning fluid containing bubbles of
20 ozone gas or the like. Therefore, gas such as ozone gas
enters the inside of the pores of the water treatment
membrane and the inside of the pores is dried, so that
filtering performance of the water treatment membrane might
be reduced. It is conceivable that a gas-liquid separation
25 device is provided between the ejector and the water

treatment membrane, but in this case, the size of the entire apparatus is enlarged.

In the method described in Patent Document 3, undissolved ozone gas is discharged to the outside air so as to keep the set pressure of the pressure ozone dissolution tank constant. Therefore, the ozone gas is partially wasted, so that the usage efficiency of the ozone gas is decreased, and in addition, an ozone treatment device such as a reducing device is needed, leading to size increase in the entire apparatus.

The present invention has been made to solve the above problems, and an object of the present invention is to provide a cleaning device and a cleaning method for a water treatment membrane, and a water treatment system, that achieve high usage efficiency of ozone gas with a simple configuration without size increase.

SOLUTION TO THE PROBLEMS

[0007] One aspect of the present invention is directed to a water treatment membrane cleaning device for a water treatment membrane for filtering and treating raw water that is a treatment target, the cleaning device being configured to cause ozone water to flow from a filtering secondary side to a filtering primary side so as to clean the water treatment membrane, the cleaning device including: an ozone

gas supply portion for generating and supplying ozone gas; an ozone dissolution tank including a gas phase portion in which the ozone gas is to be accumulated and a liquid phase portion formed by water in which the ozone gas is to be dissolved,

5 the ozone dissolution tank being configured to generate ozone water by dissolving the ozone gas supplied from the ozone gas supply portion, into the water forming the liquid phase portion; first ozone gas supply means for supplying the ozone gas from the ozone gas supply portion to the gas phase

10 portion; second ozone gas supply means for supplying the ozone gas from the ozone gas supply portion to the liquid phase portion; and ozone water supply means for supplying the ozone water generated in the ozone dissolution tank, to the filtering secondary side, wherein the ozone water is supplied

15 to the filtering secondary side by a pressure of the ozone gas in the gas phase portion.

[0008] Another aspect of the present invention is directed to a water treatment membrane cleaning method for a water treatment membrane for filtering and treating raw water that

20 is a treatment target, the cleaning method causing ozone water to flow from a filtering secondary side to a filtering primary side so as to clean the water treatment membrane, the cleaning method including: an ozone water generation step of, while accumulating ozone gas in a gas phase portion of an

25 ozone dissolution tank for generating ozone water, supplying

ozone gas to a liquid phase portion of the ozone dissolution tank, and dissolving the ozone gas into water forming the liquid phase portion, to generate ozone water; and an ozone water supply step of supplying ozone gas to the gas phase
5 portion, and supplying the ozone water generated in the ozone water generation step to the filtering secondary side by a pressure of the ozone gas in the gas phase portion, so as to clean the water treatment membrane.

10 EFFECT OF THE INVENTION

[0009] The present invention can provide a cleaning device and a cleaning method for a water treatment membrane, and a water treatment system, that achieve high usage efficiency of ozone gas with a simple configuration without size increase.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0010] [FIG. 1] FIG. 1 is a diagram schematically showing the entire configuration of a water treatment system according to embodiment 1 of the present invention.

20 [FIG. 2] FIG. 2 is a flowchart showing a cleaning method for a water treatment membrane according to embodiment 1 of the present invention.

[FIG. 3] FIG. 3 is a flowchart showing an ozone water generation step according to embodiment 1 of the
25 present invention.

[FIG. 4] FIG. 4 is a diagram schematically showing the entire configuration of the water treatment system in the ozone water generation step according to embodiment 1 of the present invention.

5 [FIG. 5] FIG. 5 is a flowchart showing an ozone water supply step according to embodiment 1 of the present invention.

[FIG. 6] FIG. 6 is a diagram schematically showing the entire configuration of the water treatment system in the
10 ozone water supply step according to embodiment 1 of the present invention.

DESCRIPTION OF EMBODIMENTS

[0011] Embodiment 1

15 Hereinafter, embodiment 1 of the present invention will be described with reference to FIG. 1 to FIG. 6. FIG. 1 is a diagram schematically showing the entire configuration of a water treatment system according to embodiment 1. FIG. 1 shows the state of the water treatment system in a
20 processing step in which raw water is treated. A water treatment system 100 includes: a membrane separation tank 81 having therein a separation membrane 82, i.e., water treatment membrane, for separating organic substances from raw water which is service water, sewage, industrial waste
25 water, or the like containing organic substances, to perform

water treatment, the membrane separation tank 81 being configured such that the outer side of the separation membrane 82 is a filtering primary side 811 and the inner side of the separation membrane 82 is a filtering secondary side 812; a cleaning device 10 for cleaning the separation membrane 82, i.e., a cleaning device for a water treatment membrane; and a treated water tank 91 for temporarily storing raw water treated in the membrane separation tank 81, as treated water.

10 [0012] The cleaning device 10 for the water treatment membrane includes an ozone gas supply portion 11, and an ozone dissolution tank 12 for generating ozone water. The ozone gas supply portion 11 is composed of a source gas supply portion (not shown) and an ozone gas generation

15 portion (not shown) for generating ozone gas using, as a source material, oxygen supplied from the source gas supply portion. The source gas generation portion is, for example, an oxygen generation device using a liquid oxygen cylinder, vacuum pressure swing adsorption (VPSA), or the like.

20 However, the source gas generation portion is not particularly limited as long as the source gas generation portion is a device or the like that can supply oxygen. The ozone gas generation portion may be a discharge-type ozone generation device, for example.

25 [0013] One end of an ozone gas supply pipe 101 is

connected to the ozone gas supply portion 11. The other end
of the ozone gas supply pipe 101 is connected to an ozone gas
flow path switch valve 13, i.e., ozone gas flow path switch
means. The ozone gas flow path switch valve 13 is connected
5 to a gas phase portion ozone gas supply pipe 102, i.e., first
ozone gas supply means, and a liquid phase portion ozone gas
supply pipe 103, i.e., second ozone gas supply means. The
ozone gas flow path switch valve 13 performs open/close
operation through control by a control device (not shown), to
10 switch the supply destination of ozone gas supplied from the
ozone gas supply pipe 101, between the gas phase portion
ozone gas supply pipe 102 and the liquid phase portion ozone
gas supply pipe 103.

[0014] The ozone dissolution tank 12 has a gas phase
15 portion 121 and a liquid phase portion 122 formed therein.
The liquid phase portion 122 is an area occupied by liquid,
and in embodiment 1, water is used as the liquid forming the
liquid phase portion 122. In the liquid phase portion 122, a
diffuser device 19 is provided which is connected to the
20 liquid phase portion ozone gas supply pipe 103 and blows
ozone gas supplied from the ozone gas supply portion 11, into
the water forming the liquid phase portion 122. The gas
phase portion 121 is formed above the liquid phase portion
122, and serves as a space in which ozone gas is accumulated
25 as described later. The top part of the ozone dissolution

tank 12 is provided with an ozone gas inflow port 123 to which the gas phase portion ozone gas supply pipe 102 is connected, and an ozone gas outflow port 124 to which a membrane separation tank ozone gas supply pipe 104, i.e.,
5 third ozone gas supply means is connected. The bottom part of the ozone dissolution tank 12 is provided with an ozone water outflow port 125 to which an ozone water supply pipe 105, i.e., ozone water supply means is connected.

In embodiment 1, the ozone gas inflow port 123 and
10 the ozone gas outflow port 124 are provided at the top part of the ozone dissolution tank 12, but the ozone gas inflow port 123 and the ozone gas outflow port 124 may be provided at such positions that allow the gas phase portion 121 to communicate with the gas phase portion ozone gas supply pipe
15 102 and the membrane separation tank ozone gas supply pipe 104. In addition, although the ozone water outflow port 125 is provided at the bottom part of the ozone dissolution tank 12, the ozone water outflow port 125 may be provided at such a position that allows the ozone water supply pipe 105 and
20 the liquid phase portion 122 to communicate with each other.

[0015] The ozone gas supply pipe 101 is provided with an ozone gas supply pressure adjustment valve 15 which performs open/close operation through control by the control device (not shown), to control flow of ozone gas between the ozone
25 gas supply portion 11 and the ozone gas flow path switch

valve 13 and adjust the pressure of the ozone gas to be supplied to the secondary side (ozone gas flow path switch valve 13 side) as seen from the ozone gas supply portion 11. The membrane separation tank ozone gas supply pipe 104 is
5 connected to the filtering primary side 811 of the membrane separation tank 81. The membrane separation tank ozone gas supply pipe 104 is provided with an ozone dissolution tank pressure adjustment valve 16 which performs open/close operation through control by the control device (not shown),
10 to control flow of ozone gas flowing through the membrane separation tank ozone gas supply pipe 104 and adjust the pressure of the gas phase portion 121 in the ozone dissolution tank 12. The ozone water supply pipe 105 is connected to the filtering secondary side 812 of the membrane
15 separation tank 81 via a three-way valve 14 and a filtering secondary side flow path pipe 106. The ozone water supply pipe 105 is provided with an ozone water supply pressure adjustment valve 17 which performs open/close operation through control by the control device (not shown), to control
20 flow of ozone water flowing through the ozone water supply pipe 105 and adjust the supply pressure of the ozone water from the liquid phase portion 122.

[0016] In the membrane separation tank 81, the separation membrane 82 is an organic hollow fiber membrane made from an
25 ozone-resistant material such as polyvinylidene fluoride

(PVDF) or polytetrafluoroethylene (PTFE), for example. The filtering primary side 811 of the membrane separation tank 81 is the entrance side for the raw water to be treated, and the filtering secondary side 812 thereof is the exit side for the raw water filtered by the separation membrane 82. The filtering primary side 811 is connected to the membrane separation tank ozone gas supply pipe 104 via a filtering primary side connection portion 813. The filtering secondary side 812 is connected to the filtering secondary side flow path pipe 106 via a filtering secondary side connection portion 814.

[0017] The treated water tank 91 is connected to the filtering secondary side 812 via the filtering secondary side flow path pipe 106, the three-way valve 14, and a treated water transfer pipe 107. The three-way valve 14 performs open/close operation through control by the control device (not shown), to control flow of fluid among the ozone water supply pipe 105, the filtering secondary side flow path pipe 106, and the treated water transfer pipe 107.

[0018] Regarding the ozone gas flow path switch valve 13, the three-way valve 14, the ozone gas supply pressure adjustment valve 15, the ozone dissolution tank pressure adjustment valve 16, and the ozone water supply pressure adjustment valve 17, an outlined part in the drawing indicates an opened state or a state in which the part is

openable in accordance with the pressure, and a filled part in the drawing indicates a closed state. That is, in FIG. 1, the ozone gas flow path switch valve 13 is in a closed state in all directions, the three-way valve 14 is in an opened
5 state between the filtering secondary side flow path pipe 106 and the treated water transfer pipe 107 and forms a flow path therebetween, and is in a closed state for the ozone water supply pipe 105 side. In addition, the ozone gas supply pressure adjustment valve 15, the ozone dissolution tank
10 pressure adjustment valve 16, and the ozone water supply pressure adjustment valve 17 are in a closed state.

[0019] Next, operation will be described. In a step for treating raw water, as shown in FIG. 1, the raw water is introduced into the membrane separation tank 81, and inside
15 the membrane separation tank 81, flow F1 of the raw water flowing from the filtering primary side 811 into the filtering secondary side 812 occurs. The raw water flowing into the filtering secondary side 812 is filtered by the separation membrane 82 so that organic substances are removed
20 therefrom, and then the filtered water is sent from the filtering secondary side 812 through the filtering secondary side flow path pipe 106, the three-way valve 14, and the treated water transfer pipe 107 to the treated water tank 91. The treated water sent to the treated water tank 91 is
25 temporarily stored therein, and then discharged to the

outside of the system. During the step for treating the raw water, since the ozone dissolution tank pressure adjustment valve 16 and the ozone water supply pressure adjustment valve 17 are in a closed state, flow is interrupted between the membrane separation tank 81 and the cleaning device 10.

[0020] After the step for treating the raw water, cleaning for the separation membrane 82 is performed. FIG. 2 is a flowchart showing a cleaning method for the water treatment membrane according to embodiment 1. The cleaning method for the water treatment membrane in the present invention includes two steps, i.e., an ozone water generation step (step ST01), and an ozone water supply step (step ST02) subsequent to the ozone water generation step. Each step will be described below.

[0021] FIG. 3 is a flowchart showing the ozone water generation step according to embodiment 1, and FIG. 4 is a diagram schematically showing the entire configuration of the water treatment system in the ozone water generation step according to embodiment 1. In the ozone water generation step, first, the ozone gas flow path switch valve 13 is opened between the ozone gas supply pipe 101 and the liquid phase portion ozone gas supply pipe 103, to form a flow path between the ozone gas supply portion 11 and the diffuser device 19 (step ST011). The ozone gas flow path switch valve 13 is closed for the gas phase portion ozone gas supply pipe

102 side, to interrupt flow between the ozone gas supply portion 11 and the gas phase portion 121. In addition, the ozone water supply pressure adjustment valve 17 is closed. The opened/closed state of the ozone dissolution tank

5 pressure adjustment valve 16 is controlled by the pressure of the gas phase portion 121 as described later.

[0022] Next, the ozone gas supply portion 11 is activated to send ozone gas to the diffuser device 19, and the ozone gas is supplied to the liquid phase portion 122 through the
10 diffuser device 19 (step ST012). At this time, the set pressure value of the ozone gas supply pressure adjustment valve 15 is equal to or greater than the value of the hydraulic head pressure applied to the diffuser device 19. The set pressure value of the ozone dissolution tank pressure
15 adjustment valve 16 is smaller than a pressure value obtained by subtracting the value of the hydraulic head pressure applied to the diffuser device 19, from the set pressure value of the ozone gas supply pressure adjustment valve 15. Setting the pressure value for the ozone dissolution tank
20 pressure adjustment valve 16 as described above allows the ozone gas to be continuously supplied into the liquid phase portion 122 from the diffuser device 19.

[0023] The ozone gas supplied to the liquid phase portion 122 is partially dissolved in the water in the liquid phase
25 portion 122, and the rest of the ozone gas is accumulated in

the gas phase portion 121 as undissolved ozone gas. The undissolved ozone gas accumulated in the gas phase portion 121 increases the pressure of the ozone gas in the gas phase portion 121. According to the Henry's law, the saturation
5 solubility of gas to water increases as the pressure of the gas increases. Therefore, the saturation solubility of ozone to water forming the liquid phase portion 122 increases with accumulation of the undissolved ozone gas in the gas phase portion 121.

10 [0024] When the pressure value of the gas phase portion 121 has become equal to or greater than the set pressure value of the ozone dissolution tank pressure adjustment valve 16 (step ST013), a part of the undissolved ozone gas flows out from the ozone gas outflow port 124 and is supplied to
15 the filtering primary side 811 of the membrane separation tank 81 via the membrane separation tank ozone gas supply pipe 104 (step ST014).

[0025] The undissolved ozone gas supplied to the filtering primary side 811 becomes bubbles in the filtering primary
20 side 811, and flows in the filtering primary side 811 as indicated by flow F2 of the undissolved ozone gas shown in FIG. 4. The bubbles of the undissolved ozone gas flowing in the filtering primary side 811 peels and removes organic substances adhered to the membrane surface of the separation
25 membrane 82 by a physical action due to shearing force and a

chemical action of the ozone gas as an oxidizing gas, thereby cleaning the membrane surface of the separation membrane 82 (step ST015). Also for adhered materials that cannot be peeled/removed by the bubbles of the undissolved ozone gas alone, an effect of weakening the strength of adhesion to the separation membrane 82 is exerted. In this way, the undissolved ozone gas supplied to the filtering primary side 811 acts as an aeration gas for cleaning the membrane surface. Thus, the undissolved ozone gas is consumed in the membrane separation tank, and contamination of the separation membrane 82 is reduced.

[0026] When the dissolved ozone concentration in the water forming the liquid phase portion 122 reaches a set concentration value and thus ozone water having a desired dissolved ozone concentration is generated in the liquid phase portion 122, the ozone water generation step is finished, to proceed to the next step, i.e., the ozone water supply step (step ST016). It is noted that the set concentration value is a predetermined value close to the saturation solubility. The higher the dissolved ozone concentration is, the higher the cleaning effect for the separation membrane 82 is. Therefore, it is preferable that the set concentration value is as close to the saturation solubility as possible. However, the saturation solubility varies depending on the temperature, pH, and the pressure of

the solvent. Therefore, in order to make the dissolved ozone concentration constant for every cleaning, the set concentration value may be a constant value equal to or greater than 30 mg/L, for example. Alternatively, an air diffusion period required for the dissolved ozone concentration to reach the set concentration value may be calculated in advance, and in the actual ozone water generation step, the air diffusion period may be set instead of the set concentration value.

10 [0027] FIG. 5 is a flowchart showing the ozone water supply step according to embodiment 1, and FIG. 6 is a diagram schematically showing the entire configuration of the water treatment system in the ozone water supply step according to embodiment 1. In the ozone water supply step, first, the ozone gas flow path switch valve 13 is opened between the ozone gas supply pipe 101 and the gas phase portion ozone gas supply pipe 102, to form a flow path between the ozone gas supply portion 11 and the gas phase portion 121, and is closed for the liquid phase portion ozone gas supply pipe 103 side, thereby switching the supply destination of the ozone gas from the liquid phase portion 122 to the gas phase portion 121 (step ST021). In addition, the ozone dissolution tank pressure adjustment valve 16 is closed. The opened/closed state of the ozone water supply pressure adjustment valve 17 is controlled by the supply

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pressure of the ozone water as described later.

[0028] Next, the three-way valve 14 is opened between the ozone water supply pipe 105 and the filtering secondary side flow path pipe 106, to form a flow path between the liquid
5 phase portion 122 and the filtering secondary side, and is closed for the treated water transfer pipe 107 side, thereby switching the flow path of the three-way valve 14.

Thereafter, ozone gas is supplied to the gas phase portion 121 through the ozone gas inflow port 123, and the ozone
10 water in the liquid phase portion 122 is transferred using the pressure of the ozone gas in the gas phase portion 121 as a drive force, so as to be supplied to the filtering secondary side 812 of the membrane separation tank 81 (step ST022). Since the ozone dissolution tank pressure adjustment
15 valve 16 is in a closed state, the pressure in the gas phase portion 121 increases with supply of the ozone gas to the gas phase portion 121, whereby a sufficient pressure for transferring the ozone water to the filtering secondary side 812 can be obtained. The ozone water in the liquid phase
20 portion 122 flows out through the ozone water outflow port 125, passes through the ozone water supply pipe 105, the three-way valve 14, and the filtering secondary side flow path pipe 106, and flows into the filtering secondary side 812.

25 [0029] As described above, while the ozone water is

supplied to the filtering secondary side 812, impurities such as organic suspended substances clogged inside the membrane are dissolved in the filtering secondary side 812, whereby the inside of the separation membrane 82 is cleaned. The
5 ozone water after used for the cleaning flows from the filtering secondary side to the filtering primary side 811 as indicated by flow F3 of the ozone water shown in FIG. 6 (step ST023).

[0030] The drive force for causing the ozone water to flow
10 from the filtering secondary side 812 to the filtering primary side 811 is based on a pressure from the gas phase portion 121, as in the transfer of the ozone water. From the standpoint of the cleaning effect for the separation membrane 82 or preventing ozone from being isolated again in the ozone
15 water during the transfer, it is preferable that the ozone water is supplied to the filtering secondary side 812 with a supply pressure as high as possible. However, if a pressure applied to the separation membrane 82 due to flow of the ozone water is excessively high, there is a possibility that
20 the pressure exceeds the withstand pressure of the separation membrane 82 and thus the separation membrane 82 is damaged. The ozone water supply pressure adjustment valve 17 is controlled so as to reduce such an excessive supply pressure, and thus the pressure of the ozone water supplied to the
25 filtering secondary side 812 is adjusted, whereby the

pressure applied to the separation membrane 82 due to flow of the ozone water is prevented from becoming excessively high. In consideration of balance between the cleaning effect of the ozone water, etc. and prevention of damage of the separation membrane, it is preferable that the set pressure value of the ozone water supply pressure adjustment valve 17 is not less than the set pressure value of the ozone dissolution tank pressure adjustment valve 16 and not greater than 300 kPa.

10 [0031] The time required for cleaning the separation membrane 82, which depends on the size or the contamination degree of the separation membrane 82, is conceivably about 30 minutes. During cleaning, supply of the ozone gas from the ozone gas supply portion 11 to the gas phase portion 121 is
15 continued and supply of the ozone water to the filtering secondary side 812 is continued, and thereafter, the supply of the ozone gas from the ozone gas supply portion 11 is stopped and thus the ozone water supply step is finished.

[0032] According to embodiment 1, the usage efficiency of
20 ozone gas can be enhanced with a simple configuration without size increase. More specifically, the gas phase portion ozone gas supply pipe and the liquid phase portion ozone gas supply pipe are provided so that ozone gas can be supplied to each of the gas phase portion and the liquid phase portion of
25 the ozone dissolution tank for generating ozone water. With

this configuration, after ozone is dissolved to the water in the liquid phase portion by the diffuser device, the supply destination of the ozone gas is switched so as to supply the ozone gas to the gas phase portion, and with the pressure of the ozone gas applied from the gas phase portion side, the ozone water is supplied to the membrane separation tank. Thus, the pressure applied to the ozone water is kept, and the ozone water can be transferred to the membrane separation tank while a high saturation solubility is maintained. Thus, the ozone is prevented from being isolated again, and the usage efficiency of the ozone gas is enhanced.

The cleaning for the separation membrane is performed with use of only ozone water, and a circulation path for increasing the dissolved ozone concentration is not needed. Therefore, the configuration is simplified and increase in cost can be prevented.

The ozone gas supplied to the gas phase portion and the undissolved ozone gas are used for increasing the pressure of the gas phase portion, and ozone in the ozone water used for the cleaning is consumed before the ozone water flows out to the filtering primary side. Therefore, a device for treating waste ozone gas, such as a reducing device using a catalyst, activated carbon, or the like, is not needed. Thus, size increase in the apparatus can be prevented, and increase in cost can be prevented.

[0033] Before cleaning for the separation membrane by the ozone water is performed in the ozone water supply step, the membrane surface of the separation membrane is cleaned from the filtering primary side, using bubbles of undissolved ozone gas in the ozone water generation step. Thus, the usage efficiency of ozone can be further enhanced. Further, since contamination of the separation membrane is reduced prior to the ozone water supply step, the supply pressure in the ozone water supply step can be reduced and the cleaning period can be shortened, whereby the amount of ozone gas required for the cleaning can be decreased. In addition, the undissolved ozone gas is consumed by being caused to react with sludge on the membrane surface or the filtering primary side. Therefore, it is not necessary to treat the undissolved ozone gas as waste ozone gas.

[0034] In embodiment 1, one ozone gas supply portion is provided and the supply destination of the ozone gas is switched by the ozone gas flow path switch valve, between the liquid phase portion and the gas phase portion of the ozone dissolution tank. However, since it is only required that the ozone gas can be supplied to both the gas phase portion and the liquid phase portion of the ozone dissolution tank, ozone gas supply portions may be respectively provided for the gas phase portion and the liquid phase portion. In this case, the ozone gas supply portion for the gas phase portion

is connected to the gas phase portion ozone gas supply pipe
 and supplies ozone gas to only the gas phase portion, and the
 ozone gas supply portion for the liquid phase portion is
 connected to the liquid phase portion ozone gas supply pipe
 5 and supplies ozone gas to only the liquid phase portion.
 Therefore, the ozone gas flow path switch valve can be
 omitted.

[0035] It is noted that, within the scope of the present
 invention, the above embodiments may be freely combined with
 10 each other, or each of the above embodiments may be modified
 or simplified as appropriate.

DESCRIPTION OF THE REFERENCE CHARACTERS

[0036] 10 cleaning device
 15 11 ozone gas supply portion
 12 ozone dissolution tank
 13 ozone gas flow path switch valve
 15 ozone gas supply pressure adjustment valve
 16 ozone dissolution tank pressure adjustment
 20 valve
 17 ozone water supply pressure adjustment valve
 81 membrane separation tank
 82 separation membrane
 100 water treatment system
 25 101 ozone gas supply pipe

- 102 gas phase portion ozone gas supply pipe
 - 103 liquid phase portion ozone gas supply pipe
 - 104 membrane separation tank ozone gas supply pipe
 - 105 ozone water supply pipe
- 5
- 121 gas phase portion
 - 122 liquid phase portion
 - 811 filtering primary side
 - 812 filtering secondary side

CLAIMS

[1] A water treatment membrane cleaning device for a water treatment membrane for filtering and treating raw water that is a treatment target, the cleaning device being
5 configured to cause ozone water to flow from a filtering secondary side to a filtering primary side so as to clean the water treatment membrane, the cleaning device comprising:

an ozone gas supply portion for generating and supplying ozone gas;

10 an ozone dissolution tank including a gas phase portion in which the ozone gas is to be accumulated and a liquid phase portion formed by water in which the ozone gas is to be dissolved, the ozone dissolution tank being configured to generate ozone water by dissolving the ozone
15 gas supplied from the ozone gas supply portion, into the water forming the liquid phase portion;

first ozone gas supply means for supplying the ozone gas from the ozone gas supply portion to the gas phase portion;

20 second ozone gas supply means for supplying the ozone gas from the ozone gas supply portion to the liquid phase portion; and

ozone water supply means for supplying the ozone water generated in the ozone dissolution tank, to the
25 filtering secondary side, wherein

the ozone water is supplied to the filtering secondary side by a pressure of the ozone gas in the gas phase portion.

5 [2] The water treatment membrane cleaning device according to claim 1, further comprising third ozone gas supply means for supplying the ozone gas accumulated in the gas phase portion to the filtering primary side.

10 [3] The water treatment membrane cleaning device according to claim 1 or 2, further comprising ozone gas flow path switch means for switching a supply destination of the ozone gas from the ozone gas supply portion, between the gas phase portion and the liquid phase portion.

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[4] A water treatment membrane cleaning method for a water treatment membrane for filtering and treating raw water that is a treatment target, the cleaning method causing ozone water to flow from a filtering secondary side to a filtering primary side so as to clean the water treatment membrane, the cleaning method comprising:

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an ozone water generation step of, while accumulating ozone gas in a gas phase portion of an ozone dissolution tank for generating ozone water, supplying ozone gas to a liquid phase portion of the ozone dissolution tank,

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and dissolving the ozone gas into water forming the liquid phase portion, to generate ozone water; and

an ozone water supply step of supplying ozone gas to the gas phase portion, and supplying the ozone water generated in the ozone water generation step to the filtering secondary side by a pressure of the ozone gas in the gas phase portion, so as to clean the water treatment membrane.

[5] The water treatment membrane cleaning method according to claim 4, wherein in the ozone water generation step, the ozone gas accumulated in the gas phase portion is supplied from the gas phase portion to the filtering primary side.

15 [6] A water treatment system comprising:
a membrane separation tank provided with a water treatment membrane for filtering raw water that is a treatment target; and
the water treatment membrane cleaning device
20 according to any one of claims 1 to 3.