[DESCRIPTION]

[TITLE OF INVENTION]

METHOD FOR OPERATING REVERSE OSMOSIS MEMBRANE DEVICE, A SLIME CONTROL METHOD, AND A WATER TREATMENT DEVICE

[Technical Field]

[0001]

The present invention relates to a method for operating a reverse osmosis membrane device, a slime control method that is applied to a reverse osmosis membrane device and a water treatment device with which the methods are performed.

[Background Art]

[0002]

Conventionally, reverse osmosis membranes (RO membranes) provided in reverse osmosis membrane devices are used to remove ions, organic substances or the like in raw water in seawater desalination, ultrapure water production, industrial water treatments, wastewater recovery treatments, reuse of wastewater and the like. In water systems having a reverse osmosis membrane device, there has been a problem in that microorganisms such as bacteria or microalgae that are contained in water to be treated turn into slime (biofilm) by the secretion or the like of an extracellular substance (for example, extracellular polysaccharide or the like), this slime is attached to and accumulated in a reverse osmosis membrane during water supply, and the microorganisms that are contained in the slime attached to the reverse osmosis membrane make the amount of the slime further increase or the like, which causes biofouling (the clogging or the like of the membrane by the slime or the like).

[0003]

Conventionally, as a method for removing slime attached to and cultivated on the surface of a reverse osmosis membrane, a method in which the operation of a reverse osmosis

membrane device is stopped, the reverse osmosis membrane is washed with a chemical such as caustic soda, and the slime is removed has been performed. However, in such a method, the continuous operation of the reverse osmosis membrane device was hindered, and an increase in the running cost was caused.

[0004]

In recent years, a method in which the operation of a reverse osmosis membrane device is not stopped, a slime inhibitor is injected into a water system that supplies water to the reverse osmosis membrane device, and slime (biofilm) attached to the surface of a reverse osmosis membrane is removed has been performed. In such a method, a variety of kinds of compounds have been studied as slime inhibitors, and a number of slime inhibition methods where this slime inhibitor is used have been proposed.

[0005]

For example, Patent Literature 1 discloses a pure water production method including a slime control agent addition step for adding a slime control agent to raw water, a membrane treatment step for performing a membrane treatment on the slime control agent-containing raw water to which the slime control agent has been added, an ultraviolet irradiation treatment step for treating a membrane-treated water on which the membrane treatment has been performed by irradiation with ultraviolet rays and an ion-exchange treatment step for performing an ion-exchange treatment on an ultraviolet irradiation-treated liquid on which the ultraviolet irradiation treatment has been performed.

[0006]

In addition, Patent Literature 2 discloses that a slime inhibition method in a reverse osmosis membrane device is a slime inhibition method that is applied to a water-passing step of water to be treated and includes a first water-passing step for adding a slime inhibitor X

of the first addition step. The horizontal axis is the operation period (hours), and the vertical axis is the addition amount.

Fig. 2 is a schematic view showing an example of the controls of the first addition step and a second addition step according to the embodiment of the present invention. a2: In the first addition step, the oxidation-based slime inhibitor is intermittently added at equal intervals. b2: In the second addition step, the organic-based slime inhibitor is continuously added during a period other than the addition period of the first addition step. The horizontal axis is the operation period (hours), and the vertical axis is the addition amount.

Fig. 3 is an example of a schematic view showing a water system having a reverse osmosis membrane device according to the embodiment of the present invention.

Fig. 4 is a view showing changes (kPa) of differential pressures in Comparative Example 2-1 (•) and Example 2-1 (♦) every water-passing period (day) in Test Example 2.

Fig. 5 is a view showing changes (kPa) of differential pressures in Comparative Example 3-1 (•) and Example 3-1 (♦) every water-passing period (day) in Test Example 3.

[Description of Embodiments]

[0016]

Hereinafter, an embodiment for carrying out the present invention will be described. The embodiment to be described below shows an example of a typical embodiment of the present invention and should not be interpreted to limit the scope of the present invention. The upper limit values and lower limit values of numerical values can be arbitrarily combined as desired.

[0017]

1. Method for operating reverse osmosis membrane device according to present embodiment

The present invention is capable of providing a method for operating a reverse osmosis

based slime inhibitor (mg/L (as total chlorine concentration)) is preferably 1 or more, more preferably 1.5 or more, still more preferably 2 or more and far still more preferably 3 or more, and a preferable upper limit value is preferably 100 or less, more preferably 50 or less and still more preferably 40 or 30 or less. When the addition concentration of the organic-based slime inhibitor is assumed to be 1 mg/L (as chemical mass), a preferable numerical range of the oxidation-based slime inhibitor (mg/L (as total chlorine concentration)) is preferably 2 to 50 and more preferably 3 to 40.

[0029]

The absolute amount (mg/(L/h)) of the oxidation-based slime inhibitor that is added to the water system per addition period is not particularly limited and can be calculated from "the addition period of the oxidation-based slime inhibitor per unit × the addition concentration of the oxidation-based slime inhibitor at that time (mg/L (as total chlorine concentration))", and a preferable lower limit value of the total chlorine concentration is preferably 0.05 mg/(L/h) or higher, more preferably 0.1 mg/(L/h) or higher, still more preferably 0.5 mg/(L/h) or higher, far still more preferably 1 mg/(L/h) or higher, more preferably 2.5 mg/(L/h) or higher, more preferably 5 mg/(L/h) or higher, more preferably 5 mg/(L/h) or higher, more preferably 10 mg/(L/h) or higher, more preferably 20 mg/(L/h) or higher, more preferably 25 mg/(L/h) or higher and more preferably 30 mg/(L/h) or higher, and a preferable lower limit value is preferably 10000 mg/(L/h) or lower, still more preferably 5000 mg/(L/h) or lower, still more preferably 1000 mg/(L/h) or lower and more preferably 500 mg/(L/h) or lower. A preferable numerical range is preferably 0.05 to 10000 mg/(L/h), more preferably 2.5 to 5000 mg/(L/h) and more preferably 2.5 to 1000 mg/(L/h).

[0030]

In addition, it is preferable that the first addition step has a period during which the

potassium chlorosulfate and the like, and it is possible to use one or more selected from these chlorosulfamates. Among these, sodium chlorosulfate is preferable.

In addition, as other chloramine compounds, chloramine T and the like can be used. In addition, it is possible to use one or more selected from these other chloramine compounds.

[0046]

<Stabilized bromide>

The stabilized bromide refers to a compound having at least one bond between a nitrogen atom (N-Cl bond) or a carbon atom and a bromine atom. The stabilized bromide does not easily change due to decomposition or the like in water, and a bromide that can be stably present in water after being generated is preferable.

Examples of the stabilized bromide include reaction products of "a reaction product of a bromine-based oxidant or a bromine compound and a chlorine-based oxide" and "a sulfamic acid compound" and the like, but the stabilized bromide is not limited thereto. The pH of the reaction product is preferably alkaline, more preferably 11 or higher, still more preferably 12 or higher and far still more preferably 13 or higher. As the stabilized bromide, a commercially available product may be used or a stabilized bromide obtained by a well-known manufacturing method may be used.

[0047]

The bromine-based oxidant is not particularly limited, examples thereof include bromine (liquid bromine), bromine chloride, bromic acid, bromate, hypobromous acid and the like, and it is possible to use one or more selected from these bromine-based oxidants.

[0048]

The bromine compound is not particularly limited, examples thereof include alkali metal bromides such as sodium bromide, potassium bromide and lithium bromide, bromide salts

or in no particular order. It is preferable that these periods come sequentially. The order of these first intermittent supply period and first addition supply-free period is preferably based on the above-described order of the first intermittent addition period and first supply-free period. In addition, the number of times of each of the first intermittent supply period and the first supply-free period during the entire operation period of the water system may be one or more.

[0065]

The one unit of the first intermittent supply period is not particularly limited, and a preferable numerical range is preferably one to 1000 minutes and more preferably 10 to 300 minutes.

The one unit of the first supply-free period is not particularly limited, and a preferable numerical range is preferably five to 100 hours and more preferably 10 to 50 hours.

[0066]

The period ratio between the first intermittent supply period per unit and the first supply-free period per unit during the total period of "the first intermittent supply period per unit and the first supply-free period per unit" is not particularly limited, but the first intermittent supply period per unit is preferably a shorter period than the first supply-free period per unit and, furthermore, more preferably 1:7 to 50.

The first intermittent supply period per unit may be an average value obtained by dividing the total period (days or the like) of the first intermittent supply periods during a certain operation period by the number of the first intermittent supply periods during this operation period. In addition, the first supply-free period per unit may be an average value obtained by dividing the total period (days or the like) of the first supply-free periods during a certain operation period by the number of the first supply-free periods during this operation period.

In addition, the operation period of the first supply step in the present embodiment may be one period of “the first intermittent supply period per unit and the first supply-free period per unit” or may be a period composed of a combination of a plurality of the same or different periods of “the first intermittent supply period per unit and the first supply-free period per unit”. This one period or plurality of periods combined is preferably based on one period of “the first intermittent addition period per unit and the first addition-free period per unit” or a plurality of the periods combined.

[0067]

1-2. Second step where organic-based slime inhibitor is used

In the second step, it is preferable that the organic-based slime inhibitor is added at least during a period other than the addition period of the first step and the water to be treated containing the organic-based slime inhibitor is supplied to the reverse osmosis membrane device.

Furthermore, the second step preferably has a second addition step for adding the organic-based slime inhibitor and a second supply step for supplying the water to be treated containing the organic-based slime inhibitor after the addition to the reverse osmosis membrane device.

[0068]

1-2-1. Second addition step

The second addition step is a step for adding the organic-based slime inhibitor at least during “the period other than the addition period of the first step”. This makes it possible to obtain water to be treated containing the organic-based slime inhibitor and makes it possible to supply the water to be treated containing the organic-based slime inhibitor after the addition to a reverse osmosis membrane device (for example, refer to Fig. 1 and Fig. 2).

[0069]

In the second addition step, the organic-based slime inhibitor is preferably added at least during “the period other than the addition period of the first step”.

[0070]

Here, “the period other than the addition period of the first step” in the second addition step is also referred to as “the addition of the organic-based slime inhibitor at least during the first addition-free period”, but the organic-based slime inhibitor may be added during both periods of the first addition-free period and the first intermittent addition period and the organic-based slime inhibitor may be added during the period of the first addition-free period only (for example, refer to Fig. 1 and Fig. 2).

The addition of the organic-based slime inhibitor in the first addition-free period in the second addition step may be the addition of the organic-based slime inhibitor in the entire period or partial period of the first addition-free period.

In addition, the addition of the organic-based slime inhibitor in the first intermittent addition period in the second addition step may be the addition of the organic-based slime inhibitor in the entire period or partial period of the first intermittent addition period.

[0071]

In addition, in the second addition step, between the entire period and partial period of the first addition-free period, the organic-based slime inhibitor is preferably added during the entire period of the first addition-free period. The partial period of the first addition-free period is preferably 50% or more, more preferably 70% or more, still more preferably 90% or more, far still more preferably 95% or more, more preferably 98% or more, still more preferably 99% or more and far still more preferably 100% (also referred to as the entire period) with respect to the entire period of the first addition-free period.

[0072]

In the second addition step, the organic-based slime inhibitor is more preferably added continuously or discontinuously during “at least the period other than the addition period of the first step”, but still more preferably added continuously and far still more preferably added at all times.

In addition, in the second addition step, the organic-based slime inhibitor is more preferably added continuously or discontinuously at least during “the first addition-free period per unit”, but still more preferably added continuously.

[0073]

In the present specification, regarding the expression “discontinuous”, a period during which the organic-based slime inhibitor is added and a period during which the addition is stopped may be present as long as the effect of the present invention is not impaired, but the addition period is preferably longer than the stop period, and the stop period is preferably 1/10 or less, more preferably 5/100 or less, still more preferably 2.5/100 or less and far still more preferably 1/500 or less of the addition period.

[0074]

In the present specification, a period during which the organic-based slime inhibitor is “continuously” added refers to “an addition period from the beginning of the addition of the organic-based slime inhibitor through the end of the addition of the organic-based slime inhibitor”, more preferably refers to “a period during which the organic-based slime inhibitor is continuously added to an extent that the effect of the present invention is not impaired” and, in a narrower sense, refers to “a period during which the organic-based slime inhibitor is continuously added with no stop of the addition”, and this is also referred to as “constant addition period”. Examples of this “constant addition period” include “zero minutes of the

chemicals that can be ordinarily used in water treatments may be used, and it is possible to appropriately adopt the configuration or the like in the description of “arbitrary component or arbitrary chemical” of the above-described “oxidation-based slime inhibitor”.

[0087]

1-2-2. Second supply step

The second supply step is preferably a step for supplying water to be treated containing the organic-based slime inhibitor to the reverse osmosis membrane device. When this second supply step and the first supply step in the first step are combined together, it is possible to operate the water system over a longer period of time. As a more preferable aspect, it is possible to inhibit biofouling that occurs in a reverse osmosis membrane provided in the reverse osmosis membrane device, and it is possible to stably operate the water system over a long period of time by inhibiting the biofouling.

[0088]

As a variety of conditions in the second supply step, it is possible to adopt the configuration or the like described in the “1-2-1. second addition step” as appropriate.

For example, as the supply period, the supply concentration of the organic-based slime inhibitor with respect to the water system, the absolute amount of the organic-based slime inhibitor that is supplied to the water system per supply period and the like in the second supply step, it is possible to adopt the addition period, the addition concentration of the organic-based slime inhibitor with respect to the water system, the absolute amount of the organic-based slime inhibitor that is added to the water system per addition period and the like in the “1-2-1. second addition step” as appropriate.

[0089]

In the second supply step, the water to be treated containing the organic-based slime

[0099]

Water to be treated containing the oxidation-based slime inhibitor and/or the organic-based slime inhibitor can be produced by Example 1 of the controls in the present embodiment. In addition, the water to be treated containing the oxidation-based slime inhibitor and/or the organic-based slime inhibitor is supplied to the reverse osmosis membrane device as the first supply step and the second supply step by Example 1 of the controls in the present embodiment. At this time, the water to be treated containing the oxidation-based slime inhibitor and/or the organic-based slime inhibitor can be supplied to the reverse osmosis membrane device in the same patterns as addition patterns of a1 and b1 as shown in Fig. 1. As a more specific example, water to be treated containing only the organic-based slime inhibitor, the water to be treated containing the oxidation-based slime inhibitor and the organic-based slime inhibitor, ··· are supplied to the reverse osmosis membrane device in order.

This makes it possible to stably operate the water system having the reverse osmosis membrane device over a longer period of time. It is possible to reduce slime that is present in the reverse osmosis membrane of the reverse osmosis membrane device or inhibit an increase in the slime more favorably, whereby biofouling can also be more favorably inhibited.

[0100]

Fig. 2 is an example of a schematic view showing Example 2 of the controls of the first addition step and the second addition step according to the embodiment of the present invention. a2 of Example 2: In the first addition step, the oxidation-based slime inhibitor is intermittently added at equal intervals. b2 of Example 2: In the second addition step, the organic-based slime inhibitor is continuously added during “the period other than the addition period of the first addition step”. The horizontal axis is the operation period (hours), and the vertical axis is the addition amount. Furthermore, an operation period 0 h of the first addition step and an

The safety filter device is capable of performing a turbid membrane removal step to be described below and may be a turbid membrane removal device. The safety filter device can be adopted as appropriate using a membrane that can be used in the turbid membrane removal device (for example, a MF membrane or the like) as the safety filter.

This makes it possible to inhibit slime in a safety filter device and also makes it possible to inhibit slime in the reverse osmosis membrane device, which is present downstream of the safety filter treatment device. In addition, it is also possible to inhibit biofouling in these membrane devices and to further inhibit biofouling in the reverse osmosis membrane device. Therefore, it is possible to operate the water system over a longer period of time.

[0104]

1-4. Application of operation method in present embodiment

[0105]

The operation method in the present embodiment can be applied to reverse osmosis membrane devices. The method of the present embodiment can be applied to slime inhibition methods, biofouling inhibition method, water systems, devices and systems.

The steps according to the present embodiment can be applied to devices or systems. For example, the first step and the second step may be set as a first method and a second method, a first device and a second device or a first system and a second system, respectively.

The operation method in the present embodiment can be applied to water systems having at least a reverse osmosis membrane device.

[0106]

The water system including the reverse osmosis membrane device is not particularly limited, and examples thereof include water treatment water systems; circulating water systems

referred to as “NF membrane”) or the like. The RO membrane is not particularly limited, and examples thereof include polyamide-based RO membranes, polyether sulfone-based RO membranes, polysulfone-based RO membranes, polyimide-based RO membranes, polyethylene imide-based RO membranes, polyethylene oxide-based RO membranes, cellulose acetate-based RO membranes and the like. Among these, polyamide-based RO membranes have a high rejection rate of ionic substances and a fast flow rate and thus have an advantage of being preferably usable.

[0115]

The conditions of the water to be treated that is supplied to the reverse osmosis membrane device in the present embodiment (hereinafter, also referred to as “supply water”) can be set as appropriate depending on the treatment capacity or purpose of the reverse osmosis membrane device or a reverse osmosis membrane step and are not particularly limited.

[0116]

Examples of the condition for the water to be treated that is supplied to the reverse osmosis membrane device (supply water) include the pH of the supply water, the amount of the supply water, the temperature of the supply water, the water pressure (MPa) of the supply water, TOC (total organic carbon) of the supply water, the oxidation-reduction potential (ORP) of the supply water and the like, and one or more can be selected from these conditions. An organic substance in the supply water is regarded as TOC.

In the present invention, “the water to be treated that is supplied to the reverse osmosis membrane device” is also referred to as “supply water supplied”, and the supply water refers to water that is introduced into the reverse osmosis membrane device and treated with a reverse osmosis membrane and corresponds to inlet water of the reverse osmosis membrane device.

[0117]

The pH of the supply water is not particularly limited, but is preferably 3 to 9, more preferably 4 to 8 and still more preferably 5 to 8. The pH may be adjusted with a pH adjuster.

The amount of the supply water is not particularly limited, but is preferably 5 to 200 mL/min.

The water pressure of the supply water is not particularly limited, but is preferably 0.1 to 10 MPa.

The water temperature of the supply water is not particularly limited, but is preferably 4°C to 50°C and more preferably 10°C to 40°C.

TOC of the supply water is not particularly limited, but is preferably 1 to 100 mg/L, more preferably 1 to 50 mg/L and still more preferably 1 to 10 mg/L.

ORP of the supply water is preferably 200 to 600 mV and more preferably 200 to 400 mV.

In addition, the flow rate of the supply water is preferably 3 to 10 m^3/h per 8-inch spiral module.

[0118]

In the present embodiment, as a more preferable aspect, a pretreatment step for removing the organic substance, the turbid substance or the like from the water to be treated in a pretreatment part before the supply of the water to be treated to the reverse osmosis membrane device may be included.

The water to be treated that is supplied to the reverse osmosis membrane device is preferably pre-treated with the safety filter device. For example, as the pretreatment step, a step for filtering the raw water (water to be treated) with the filtration device and passing the filtration-treated water through the filtration-treated water tank and the safety filter or the like can be exemplified.

This makes it possible to obtain pretreated water to be treated that is supplied to the reverse osmosis membrane device or the reverse osmosis membrane step.

The safety filter is not particularly limited, examples thereof include one or a plurality of microfiltration membrane (MF membrane) treatments, one or a plurality of ultrafiltration membrane (UF membrane) treatments and the like, it is possible to use one or more from these, and these may be combined as appropriate. This makes it possible to reduce an impurity such as the turbid substance of the water to be treated that is supplied to the reverse osmosis membrane device.

[0119]

In the present embodiment, since the water to be treated that is supplied to the reverse osmosis membrane device more favorably contains the oxidation-based slime inhibitor and/or the organic-based slime inhibitor, it is possible to more favorably inhibit biofouling that occurs in the reverse osmosis membrane device as appropriate, and it is also possible to more favorably and efficiently exhibit an effect attributed to the oxidation-based slime inhibitor and/or the organic-based slime inhibitor (for example, antibacterial, sterilization, algicide, microbial growth inhibition, microbial metabolism inhibition or the like) as appropriate. This makes it possible to expect an effect of inhibiting biofouling that occurs in the reverse osmosis membrane device and also an effect attributed to a chemical that is used.

[0120]

1-5. Each measurement method

<Method for calculating total residual chlorine concentration>

The total residual chlorine concentration is calculated based on the following method. It is possible to refer to JIS K 0400-33-10: 1999.

Total residual chlorine concentration = free chlorine concentration + activated

combined chlorine concentration + stabilized combined chlorine concentration

Free chlorine concentration: Free chlorine concentration by a DPD method (pocket calorimeter, chlorine, manufactured by DKK-TOA Corporation) [here, the free chlorine concentration by the DPD method is a measurement result of the chlorine concentration (mg-Cl_2/L) after five to 30 seconds with a DPD (Free) reagent, which is a reagent for measuring free chlorine]

Activated combined chlorine concentration: A value obtained by subtracting the measurement result of the free chlorine concentration (mg-Cl_2/L) from a measurement result of the chlorine concentration (mg-Cl_2/L) after 300 seconds with the DPD (Free) reagent, which is a reagent for measuring free chlorine

Stabilized combined chlorine concentration: A value obtained by subtracting the measurement result of the chlorine concentration (mg-Cl_2/L) after 300 seconds with the DPD (Free) reagent, which is a reagent for measuring free chlorine, from a measurement result of the chlorine concentration (mg-Cl_2/L) after 180 seconds with a DPD (Total) reagent, which is a reagent for measuring total chlorine

Free chlorine percentage (%) = (free chlorine concentration/total residual chlorine concentration) × 100

Stabilized combined chlorine percentage (%) = (stabilized combined chlorine concentration/total residual chlorine concentration) × 100

The temperature of the testing environment is set to 25°C.

[0121]

The pH (25°C) of the water to be treated can be measured with a handy pH meter manufactured by Horiba Corporation. In addition, TOC of the water to be treated can be measured with a TOC meter. ORP of the water to be treated can be measured with an ORP

chemical addition part and the second chemical addition part and controlling these steps in the first step and the second step.

[0131]

As a preferable aspect, the control part is capable of controlling and performing the first step and the second step by commanding a more preferable chemical addition status (the addition timing (intermittent or continuous), the addition concentration or the like) to each of the first chemical addition part and the second chemical addition part based on the supply state. This makes it possible to stably operate the water system having the reverse osmosis membrane device over a longer period of time. Furthermore, this makes it possible to reduce slime that is present in the reverse osmosis membrane of the reverse osmosis membrane device or inhibit an increase in the slime more favorably, whereby biofouling can also be more favorably inhibited.

[0132]

As a more preferable aspect, the control part preferably performs the following step 11 and step 21 in parallel at the same time and, furthermore, more preferably performs the following step 12 and step 22 in parallel at the same time. In addition, the control part is capable of preparing water to be treated containing the oxidation-based slime inhibitor and/or the organic-based slime inhibitor while adjusting the addition amounts of the oxidation-based slime inhibitor and the oxidation-based slime inhibitor to the water to be treated, the addition time or addition period thereof or the like in the first addition step and the second addition step. The control part is capable of supplying the water to be treated containing the oxidation-based slime inhibitor and/or the organic-based slime inhibitor prepared in the first addition step and the second addition step to the reverse osmosis membrane device in the first supply step and the second supply step. The control part is capable of stably operating the water system having the reverse osmosis membrane device over a longer period of time as described above. This makes

described in the “1.” and “2.”) or control parts including the devices (the control part includes CPU, a processor or the like), and it is possible to provide these device or control parts. Examples of the devices for performing or managing the methods include computers, notebook computers, disc top personal computers, tablet PCs, PLCs, servers, cloud services and the like. Furthermore, the devices or the like for performing or managing the methods may be provided with an input part such as a touch panel or a keyboard, transmission and reception parts or a network between individual parts, a communication part such as a network access part, a display part such as a touch panel or a display or the like as appropriate. This makes it possible to perform the methods of the present embodiment. The devices for performing or managing the methods are capable of including, as the configuration, for example, CPU, RAM, a storage part, a display part, a communication part and the like as appropriate, and, in the configuration, the individual parts may be connected to each other through, for example, a path as a data transmission and reception part as necessary.

[0137]

In addition, the methods of the present embodiment can also be housed in a hardware resource including a storage medium (a non-volatile memory (USB memory or the like), SSD (solid state drive), HDD (hard disk drive), CD, DVD, Blur-ray disc or the like) as a program and be realized with the above-described control part. The methods of the present embodiment can be provided as a program. It is possible to provide a storage medium storing the methods of the present embodiment. This makes it possible to perform the methods of the present embodiment.

[0138]

In addition, it is possible to provide a device, a water treatment device, a system, a water-based system or the like for performing the operation, slime control or the like of a reverse

the method according to any one of [1] to [9], in which the water treatment device or the water treatment water system may include a control part or a control device, may include CPU in the control part and the control device is preferably a computer device. The water treatment device or the water treatment water system may be a water treatment device or a water treatment water system having the control part or the control device.

[0144]

· [12] A slime control system that is applied to an operation system of a reverse osmosis membrane device or a reverse osmosis membrane device, the slime control system causing a computer to perform the method according to any one of [1] to [9].

· [13] A program that causes a computer to perform the method according to any one of [1] to [9].

· [14] A program that causes a computer to realize operation of a reverse osmosis membrane device, a computer readable medium housing the program or a device including the program or the medium including a first function that performs a first step for intermittently adding an oxidation-based slime inhibitor and intermittently supplying water to be treated containing the oxidation-based slime inhibitor to a reverse osmosis membrane device and

a second function that performs a second step for adding an organic-based slime inhibitor at least during a period other than the addition period of the first step and supplying the water to be treated containing the organic-based slime inhibitor to the reverse osmosis membrane device. A control part, a water treatment device, a control system or a water treatment water system configured to perform the program.

Examples

[0145]

Hereinafter, the embodiment of the present disclosure will be described using the

Table 1 was measured using a membrane fouling simulator that is in Non-Patent Literature 1 (J. S. Vrouwenvelder et. al.), and the day where this differential pressure was reached was regarded as a day when biofouling occurred, that is, an occlusion day. It is evaluated that, as the number of days taken until this occlusion increases, slime can be inhibited more favorable.

[0148]

[Comparative Example 1-1]: No chemical added

[Comparative Example 1-2]: At 1.5 mg/L as total chlorine concentration (T-Cl) of sodium monochlorosulfamate, this pure chemical was added at all times from day 0 from the beginning until occlusion occurred.

Comparative Example 3: At 0.15 mg/L as Cl-MIT of Cl-MIT, this pure chemical was added at all times from day 0 from the beginning until occlusion occurred.

[Example 1-1]: A first step of <J1-1> and a second step of <J2-2> were performed together in parallel.

In <J1-1>, at 6 mg/L as T-Cl of sodium monochlorosulfamate, which is an oxidation-based slime inhibitor, the water to be treated was added for two hours from 8 a.m. every day from day 0 from the beginning, and the water to be treated containing the chemical was supplied to the RO membrane device.

In <J2-2>, at 0.15 mg/L as chemical mass (Cl-MIT) of Cl-MIT (5-chloro-2-methyl-4-isothiazolin-3-one), which is an organic-based slime inhibitor, the water to be treated was added at all times from day 0 from the beginning, and the water to be treated containing the chemical was supplied to the RO membrane device. In the case of addition at all times, the addition of the chemical to the water to be treated began from day 0, the chemical was continuously added to the water to be treated with no stop of the addition of the chemical, and the water to be treated containing the chemical was supplied to a reverse osmosis membrane device. Regarding periods

certain time" and then continuous addition of the oxidation-based slime inhibitor of the first step during the period during which the addition of the organic-based slime inhibitor of the second step was stopped were repeatedly performed in this order.

Therefore, the oxidation-based slime inhibitor is intermittently added, and the water to be treated containing the oxidation-based slime inhibitor is continuously passed through the reverse osmosis membrane device for "a certain time" On the other hand, the organic-based slime inhibitor is continuously added during "the period other than the addition period of the first step", and the water to be treated containing the organic-based slime inhibitor is continuously passed through the reverse osmosis membrane device during "the period other than the addition period of the first step".

[0155]

Specifically, Cl-MIT, which was the organic-based slime inhibitor that was used in the second step, was continuously added at 0.1 mg/L as chemical mass (Cl-MIT) for a period of 23.5 hours from 9:30 every day through 9:00 of the next day, water was continuously passed through the RO membrane device downstream thereof during this predetermined period, monochlorosulfanic acid, which was the oxidation-based slime inhibitor that was used in the first step, was continuously added at 5 mg/L as T-Cl for a period of 0.5 hours from 9:00 through 9:30 every day, and water was continuously passed through the RO membrane device downstream thereof during this predetermined period. Therefore, the water to be treated containing the organic-based slime inhibitor, the water to be treated containing the oxidation-based slime inhibitor, the water to be treated containing the organic-based slime inhibitor, ··· are supplied to the reverse osmosis membrane device in this order.

[0156]

The results of the changes (kpa) in the differential pressures for up to six days in

[0168]

[Table 2]

Table 2: Test Example 4

	Chemical addition conditions				Number of days until occlusion [days]
	Sodium monochlorosulfamate		Cl-MIT		
	1 mg/L as T-Cl added at all times	25 mg/L as T-Cl added intermittently (9:00 to 9:30 every day)	0.5 mg/L as Cl-MIT added at all times	13 mg/L as Cl-MIT added intermittently (21:00 to 21:30 every day)	
Comparative Example 4-1	-	-	-	-	10
Comparative Example 4-2	O	-	-	-	12
Comparative Example 4-3	-	O	-	-	30
Comparative Example 4-4	-	-	O	-	32
Comparative Example 4-5	-	-	-	O	18
Comparative Example 4-6	O	-	O	-	36
Comparative Example 4-7	O	-	-	O	22
Example 4-1	-	O	O	-	48
O means that there is RUN (addition). - means that there is no RUN (no addition).					

[Reference Signs List]

[0169]

1 Water system

2 Reverse osmosis membrane device

3 Safety filter

4 Solid-liquid separation device

5 Condensation device

10 First chemical addition device

20 Second chemical addition device