[0010] [1] A silica fouling inhibition method for a reverse osmosis membrane system, wherein an acrylic acid-based polymer and/or a maleic acid-based polymer; and a combined chlorine-based oxidizing agent and/or a combined bromine-based oxidizing agent are allowed to be present in water to be treated.

[0011] [2] The silica fouling inhibition method according to [1], wherein the acrylic acid-based polymer and/or the maleic acid-based polymer is at least one type of polymer selected from a group consisting of the following: a copolymer of polyacrylic acid, polymaleic acid, acrylic acid, and acrylamide methylpropanesulfonic acid; a terpolymer of acrylic acid, acrylamide methylpropanesulfonic acid, and N-substituted acrylamide; a copolymer of acrylic acid and sodium allyloxyhydroxypropane sulfonate; a copolymer of maleic anhydride, vinyl acetate, and acrylic acid alkyl ester; and a copolymer of maleic anhydride and isobutylene.

[0012] The silica fouling inhibition method according to [1], wherein the acrylic acid-based polymer is a copolymer of acrylic acid and acrylamide methylpropanesulfonic acid, or a terpolymer of acrylic acid, acrylamide methylpropanesulfonic acid, and N-substituted acrylamide.

[0013] [4] The silica fouling inhibition method according to any one of [1] to [3], wherein the combined chlorine-based oxidizing agent is a chlorosulfamic acid compound.

[0014] [5] A silica fouling inhibitor for a reverse osmosis membrane system, comprising: a copolymer of acrylic acid and acrylamide methylpropanesulfonic acid and/or a terpolymer of acrylic acid, acrylamide methylpropanesulfonic acid, and N-substituted acrylamide; and a combined chlorine-based oxidizing agent and/or a combined bromine-based oxidizing agent.

[0015] [6] The silica fouling inhibitor according to [5], wherein the combined chlorine-based oxidizing agent is a chlorosulfamic acid compound.

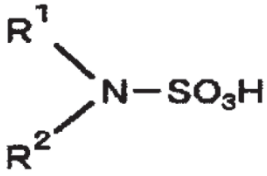
Effects of the Invention

[0016] In the present invention, by allowing both the polymer as the scale inhibitor and the combined chlorine-based oxidizing agent and/or the combined bromine-based oxidizing agent as an auxiliary agent present in water to be treated, not only the scale on the Tail side of the reverse

as barium chlorite, other metal chlorites, such as nickel chlorite, alkali metal chlorates such as ammonium chlorate, sodium chlorate, potassium chlorate, alkaline earth metal chlorates such as calcium chlorate and barium chlorate, etc. These chlorine-based oxidizing agents may be used alone or in combination of two or more. Among these, hypochlorite is easy to handle and may be preferably used.

[0026] Examples of the sulfamic acid compounds used in the present invention include a compound represented by the general formula [1] below or a salt thereof.

[0027] [Chemical formula 1]



…[1]

[0028] However, in the general formula [1], R^1 and R^2 are each independently hydrogen or a hydrocarbon group having 1 to 8 carbon atoms.

[0029] Examples of such sulfamic acid compounds include, in addition to sulfamic acid in which R^1 and R^2 are both hydrogen, N-methylsulfamic acid, N,N-dimethylsulfamic acid, N-phenylsulfamic acid, etc.

[0030] Examples of the salts of sulfamic acid compound include alkali metal salts such as sodium salts and potassium salts, alkaline earth metal salts such as calcium salts, strontium salts, barium salts, other metal salts such as manganese salts, copper salts, zinc salts, iron salts, cobalt salts, nickel salts, and ammonium salts and guanidine salts, etc., and specifically, include sodium sulfamate, potassium sulfamate, calcium sulfamate, strontium sulfamate, barium sulfamate, iron sulfamate, zinc sulfamate, etc. Sulfamic acid and these sulfamic acid salts may be used alone or in combination of two or more.

[0031] The acrylic acid-based polymer and/or the maleic acid-based polymer are preferably added so that the concentration in the water to be treated is 0.1 to 5 mg/L, particularly 0.15 to 3

[0047] After water passage, when the membrane on the Lead side was disassembled and analyzed by SEM-EDS, silica fouling was confirmed on the membrane surface as a whole, and when the contaminated membrane was cut out and subjected to XRF analysis, 32.0 wt% Si was detected. When this deposit was scraped off and the acid-insoluble content was analyzed, it was detected to be 11.4 wt%. According to this result, simply adding a scale inhibitor may not prevent silica fouling occurring on the Lead side.

[0048] [Table 2]

Item	Value
Conductivity [mS/m]	27.0
pH	7.49
Total hardness [mg/L]	225.5
Chloride ion	15.6
Sulfate ion	24.0
Nitrate ion	8.1
Silica (SiO_2)	4.3
Potassium	2.8
Iron	0.05

[0049] [Comparative Example 3]

Water having the water quality shown in Table 3 was passed through a reverse osmosis membrane system (manufactured by Kurita Water Industries Ltd.) at a recovery rate of 50%. Although a scale inhibitor was not added and a combined chlorine-based oxidizing agent (manufactured by Kurita Water Industries Ltd.) was added at 2 mg/L as Cl_2, an increase in modular differential pressure was confirmed.

[0050] After water passage, when the membrane on the Lead side was disassembled and analyzed by SEM-EDS, silica fouling was confirmed on the membrane surface as a whole. When this deposit was scraped off and the acid-insoluble content was analyzed, it was detected to be 4.6 wt%. According to this result, simply adding a combined chlorine-based oxidizing agent may not prevent silica fouling occurring on the Lead side.

[0051] [Table 3]

Item	Value
Conductivity [mS/m]	123

CLAIMS

[Claim 1]

A silica fouling inhibition method for a reverse osmosis membrane system, wherein

an acrylic acid-based polymer and/or a maleic acid-based polymer; and

a combined chlorine-based oxidizing agent and/or a combined bromine-based oxidizing agent are allowed to be present in water to be treated.

[Claim 2]

The silica fouling inhibition method for the reverse osmosis membrane system according to claim 1, wherein the acrylic acid-based polymer and/or the maleic acid-based polymer is at least one type of polymer selected from a group consisting of: a copolymer of polyacrylic acid, polymaleic acid, acrylic acid, and acrylamide methylpropanesulfonic acid; a terpolymer of acrylic acid, acrylamide methylpropanesulfonic acid, and N-substituted acrylamide; a copolymer of acrylic acid and sodium allyloxyhydroxypropane sulfonate; a copolymer of maleic anhydride, vinyl acetate, and acrylic acid alkyl ester; and a copolymer of maleic anhydride and isobutylene.

[Claim 3]

The silica fouling inhibition method for the reverse osmosis membrane system according to claim 1, wherein the acrylic acid-based polymer is a copolymer of acrylic acid and acrylamide methylpropanesulfonic acid, or a terpolymer of acrylic acid, acrylamide methylpropanesulfonic acid, and N-substituted acrylamide.

[Claim 4]

The silica fouling inhibition method for the reverse osmosis membrane system according to any one of claims 1 to 3, wherein the acrylic acid-based polymer is a copolymer obtained by copolymerizing acrylic acid (AA) and acrylamide methylpropanesulfonic acid (AMPS) in a ratio of AA:AMPS=50 to 99:1 to 50 (molar ratio).

[Claim 5]

The silica fouling inhibition method for the reverse osmosis membrane system according to any one of claims 1 to 4, wherein a weight average molecular weight of the acrylic acid-based polymer is 1000 to 50000.

[Claim 6]

The silica fouling inhibition method for the reverse osmosis membrane system according to any one of claims 1 to 5, wherein the combined chlorine-based oxidizing agent is a chlorosulfamic acid compound.

[Claim 7]

The silica fouling inhibition method for the reverse osmosis membrane system according to claim 1, wherein the acrylic acid-based polymer and/or the maleic acid-based polymer are added to water to be treated so that a concentration in the water to be treated becomes 0.1 to 5 mg/L, and a chlorosulfamic acid compound is added to the water to be treated so that a concentration in the water to be treated becomes 0.1 to 10 mg/L as Cl_2.

[Claim 8]

A silica fouling inhibitor for a reverse osmosis membrane system, comprising:

a copolymer of acrylic acid and acrylamide methylpropanesulfonic acid and/or a terpolymer of acrylic acid, acrylamide methylpropanesulfonic acid, and N-substituted acrylamide; and

a combined chlorine-based oxidizing agent and/or a combined bromine-based oxidizing agent.

[Claim 9]

The silica fouling inhibitor for the reverse osmosis membrane system according to claim 8, wherein the combined chlorine-based oxidizing agent is a chlorosulfamic acid compound.