CLAIMS

{Claim 1}

A de-ionization treatment device comprising:

a de-ionization unit provided with a capacitive de-ionization treatment unit having a pair of opposing electrodes that are charged to have opposite polarities with each other, a flow passageway that is located between the electrodes and enables passage of supplied water containing ions, and an ion-exchange membrane disposed on a flow passageway side of each of said electrodes;

an injection unit connected to a pipe through which said supplied water passes on an upstream side of said capacitive de-ionization treatment unit, for injecting a scale inhibiting agent into said supplied water; and

a controlling unit, wherein

said controlling unit includes ~~at least one of~~a regeneration-time controlling unit that starts injection of said scale inhibiting agent from said injection unit for a period of time t_a that is determined by formula (1) on the basis of a retained water amount of said de-ionization unit and a flow rate of said supplied water while de-ionization is carried out in said capacitive de-ionization treatment unit or simultaneously with the start of regeneration of said capacitive de-ionization treatment unit, and stops injection of said scale inhibiting agent from said injection unit when a

predetermined period of time passes after the start of injection of said scale inhibiting agent or when a concentration of said ions in said supplied water discharged from said capacitive de-ionization treatment unit reaches a predetermined amount, and

the period of time t_a is set to be a period of time corresponding to an amount within a range of 0 times to 3 times as large as said retained water amount.

$t_a = mW / Q \quad \ldots (1)$

m: coefficient ($0 \leq m \leq 3$)

W: retained water amount (m^3)

Q: supplied water flow rate (m^3/h)

{Claim 2}

A de-ionization treatment device comprising:

a de-ionization unit provided with a capacitive de-ionization treatment unit having a pair of opposing electrodes that are charged to have opposite polarities with each other, a flow passageway that is located between the electrodes and enables passage of supplied water containing ions, and an ion-exchange membrane disposed on a flow passageway side of each of said electrodes;

an injection unit connected to a pipe through which said supplied water passes on an upstream side of said capacitive de-ionization treatment unit, for injecting a scale inhibiting

agent into said supplied water; and

a controlling unit, wherein

said controlling unit includes a stoppage-time controlling unit that allows injection of a predetermined amount of said scale inhibiting agent from said injection unit at the time of stoppage of said capacitive de-ionization treatment unit and stops injection of said scale inhibiting agent from said injection unit when a predetermined period of time passes after the start of injection of said scale inhibiting agent at the time of the stoppage of said capacitive de-ionization treatment unit.

{Claim 3}

A de-ionization treatment device comprising:

a de-ionization unit provided with a capacitive de-ionization treatment unit having a pair of opposing electrodes that are charged to have opposite polarities with each other, a flow passageway that is located between the electrodes and enables passage of supplied water containing ions, and an ion-exchange membrane disposed on a flow passageway side of each of said electrodes;

an injection unit connected to a pipe through which said supplied water passes on an upstream side of said capacitive de-ionization treatment unit, for injecting a scale inhibiting agent into said supplied water; and

a controlling unit, wherein

said controlling unit includes at least one of:

a regeneration-time controlling unit that starts injection of said scale inhibiting agent from said injection unit for a period of time t_a that is determined by formula (1) on the basis of a retained water amount of said de-ionization unit and a flow rate of said supplied water while de-ionization is carried out

in said capacitive de-ionization treatment unit or simultaneously with the start of regeneration of said capacitive de-ionization treatment unit, and stops injection of said scale inhibiting agent from said injection unit when a predetermined period of time passes after the start of injection of said scale inhibiting agent or when a concentration of said ions in said supplied water discharged from said capacitive de-ionization treatment unit reaches a predetermined amount, and

a stoppage-time controlling unit that allows injection of a predetermined amount of said scale inhibiting agent from said injection unit at the time of stoppage of said capacitive de-ionization treatment unit and stops injection of said scale inhibiting agent from said injection unit when a predetermined period of time passes after the start of injection of said scale inhibiting agent at the time of the stoppage of said capacitive de-ionization treatment unit, and

the period of time t_a is set to be a period of time corresponding to an amount within a range of 0 times to 3 times as large as said retained water amount.

$t_a = mW / Q \quad \ldots (1)$

m: coefficient ($0 \leq m \leq 3$)

W: retained water amount (m^3)

Q: supplied water flow rate (m^3/h)

{Claim 4}

A de-ionization treatment device comprising:

a de-ionization unit provided with a capacitive de-ionization treatment unit having a pair of opposing electrodes that are charged to have opposite polarities with each other, a flow passageway that is located between the electrodes and enables passage of supplied water containing ions, and an ion-

exchange membrane disposed on a flow passageway side of each of said electrodes;

a low ion concentration water supplying unit connected to a pipe through which said supplied water passes on an upstream side of said capacitive de-ionization treatment unit, for feeding a low ion concentration water having a lower ion concentration than said supplied water to said capacitive de-ionization treatment unit;

a supplied water pump that supplies supplied water to said capacitive de-ionization treatment unit; and

a controlling unit, wherein

said controlling unit includes a treatment controlling unit that stops said supplied water pump and said capacitive de-ionization treatment unit when the amount of water supplied to said capacitive de-ionization treatment unit is below or equal to a prescribed value or when the amount of treated water reaches a prescribed value, and a stoppage-time controlling unit that feeds said low ion concentration water in an amount based on the retained water amount of said de-ionization unit to said capacitive de-ionization treatment unit after the stop of said capacitive de-ionization treatment unit.

{Claim 5}

A de-ionization treatment device comprising:

a de-ionization unit provided with a capacitive de-ionization treatment unit having a pair of opposing electrodes that are charged to have opposite polarities with each other, a flow passageway that is located between the electrodes and enables passage of supplied water containing ions, and an ion-exchange membrane disposed on a flow passageway side of each of said electrodes;

an injection unit connected to a pipe through which said supplied water passes on an upstream side of said capacitive de-ionization treatment unit, for injecting a scale inhibiting agent into said supplied water;

a low ion concentration water supplying unit connected to a pipe through which said supplied water passes on an upstream side of said capacitive de-ionization treatment unit, for feeding a low ion concentration water having a lower ion concentration than said supplied water to said capacitive de-ionization treatment unit; and

a controlling unit, wherein

said controlling unit includes one or both of a regeneration-time controlling unit and a stoppage-time injection unit controlling unit, and a low ion concentration water supplying unit controlling unit,

said regeneration-time controlling unit starts injection of said scale inhibiting agent from said injection unit for a period of time t_a that is determined by formula (1) on the

basis of a retained

water amount of said de-ionization unit and a flow rate of said supplied water while de-ionization is carried out in said capacitive de-ionization treatment unit or simultaneously with the start of regeneration of said capacitive de-ionization treatment unit, and stops injection of said scale inhibiting agent from said injection unit when a predetermined period of time passes after the start of injection of said scale inhibiting agent or when a concentration of said ions in said supplied water discharged from said capacitive de-ionization treatment unit reaches a predetermined amount,

said stoppage-time injection unit controlling unit allows injection of a predetermined amount of said scale inhibiting agent from said injection unit at the time of stoppage of said capacitive de-ionization treatment unit and stops injection of said scale inhibiting agent from said injection unit when a predetermined period of time passes after the start of injection of said scale inhibiting agent at the time of the stoppage of said capacitive de-ionization treatment unit, ~~and~~

said low ion concentration water supplying unit controlling unit feeds said low ion concentration water in an amount based on the retained water amount of said de-ionization unit to said capacitive de-ionization treatment unit after said capacitive de-ionization treatment unit is stopped, and

the period of time t_a is set to be a period of time

corresponding to an amount within a range of 0 times to 3 times as large as said retained water amount.

$t_a = mW / Q$ ... (1)

m: coefficient ($0 \leq m \leq 3$)

W: retained water amount (m^3)

Q: supplied water flow rate (m^3/h)

~~{Claim 6}~~

~~The de-ionization treatment device according to any of claim 1, 3 or 5, wherein the period of time during which said scale inhibiting agent is injected while de-ionization is carried out in said capacitive de-ionization treatment unit is set to be a period of time corresponding to an amount within a range of 0 times to 3 times as large as said retained water amount.~~

{Claim 6 ~~7~~}

The de-ionization treatment device according to claim 4 or 5, wherein the amount of said low ion concentration water fed to said capacitive de-ionization treatment unit is set to be an amount corresponding to 3 times or more as large as said retained water amount.

{Claim 7 ~~8~~}

A method for operating a de-ionization treatment device according to claim 1, comprising:

a de-ionization step of allowing supplied water containing ions to pass between a pair of opposing electrodes in a state in which one electrode is charged to be positive and the other electrode is charged to be negative, so as to allow negative ions to be adsorbed onto said one electrode and to allow positive ions to be adsorbed onto said other

electrode, thereby to remove said ions from said supplied water;

a regeneration step of allowing said supplied water to pass between said electrodes in a state in which said one electrode is charged to be negative and said other electrode is charged to be positive, so as to eliminate said negative ions from said one electrode to release said negative ions into said supplied water and to eliminate said positive ions from said other electrode to release said positive ions into said supplied water, thereby to regenerate said electrodes; and

a regeneration-time addition step, wherein

said regeneration-time addition step includes:

a first injection step of injecting said scale inhibiting agent into said supplied water for a period of time t_a that is determined by formula (1) on the basis of a retained water amount of said de-ionization unit and a flow rate of said supplied water during said de-ionization step or simultaneously with the start of said regeneration step, and

a first injection stoppage step of stopping the injection of said scale inhibiting agent when a predetermined period of time passes after the start of said first injection step or when a concentration of said ions in said supplied water discharged from said capacitive de-ionization treatment unit reaches a predetermined amount, and

the period of time t_a is set to be a period of time corresponding to an amount within a range of 0 times to 3 times as large as said retained water amount.

$t_a = mW / Q$ ... (1)

m: coefficient ($0 \leq m \leq 3$)

W: retained water amount (m^3)

Q: supplied water flow rate (m^3/h)

{Claim 8 ~~9~~}

A method for operating a de-ionization treatment device according to claim 2, comprising:

a de-ionization step of allowing supplied water containing ions to pass between a pair of opposing electrodes in a state in which one electrode is charged to be positive and the other electrode is charged to be negative, so as to allow negative ions to be adsorbed onto said one electrode and to allow positive ions to be adsorbed onto said other electrode, thereby to remove said ions from said supplied water;

a regeneration step of allowing said supplied water to pass between said electrodes in a state in which said one electrode is charged to be negative and said other electrode is charged to be positive, so as to eliminate said negative ions from said one electrode to release said negative ions into said supplied water and to eliminate said positive ions from said other electrode to release said positive ions into said supplied water, thereby to regenerate said electrodes; and

a stoppage-time addition step, wherein

said stoppage-time addition step includes:

a second injection step of allowing injection of a predetermined amount of said scale inhibiting agent from said injection unit at the time of stoppage of said capacitive de-

ionization treatment unit, and

a second injection stoppage step of stopping injection of said scale inhibiting agent from said injection unit when a predetermined period of time passes after the start of said second injection step.

{Claim 9 ~~10~~}

A method for operating a de-ionization treatment device according to claim 3, comprising:

a de-ionization step of allowing supplied water containing ions to pass between a pair of opposing electrodes in a state in which one electrode is charged to be positive and the other electrode is charged to be negative, so as to allow negative ions to be adsorbed onto said one electrode and to allow positive ions to be adsorbed onto said other electrode, thereby to remove said ions from said supplied water;

a regeneration step of allowing said supplied water to pass between said electrodes in a state in which said one electrode is charged to be negative and said other electrode is charged to be positive, so as to eliminate said negative ions from said one electrode to release said negative ions into said supplied water and to eliminate said positive ions from said other electrode to release said positive ions into

said supplied water, thereby to regenerate said electrodes; and

an addition step of adding a scale inhibiting agent into said supplied water, wherein

said addition step includes at least one of a regeneration-time addition step and a stoppage-time addition step,

said regeneration-time addition step includes:

a first injection step of injecting said scale inhibiting agent into said supplied water for a period of time t_a that is determined by formula (1) on the basis of a retained water amount of said de-ionization unit and a flow rate of said supplied water during said de-ionization step or simultaneously with the start of said regeneration step, and

a first injection stoppage step of stopping the injection of said scale inhibiting agent when a predetermined period of time passes after the start of said first injection step or when a concentration of said ions in said supplied water discharged from said capacitive de-ionization treatment unit reaches a predetermined amount, ~~and~~

said stoppage-time addition step includes:

a second injection step of allowing injection of a predetermined amount of said scale inhibiting agent from said injection unit at the time of stoppage of said capacitive de-ionization treatment unit, and

a second injection stoppage step of stopping injection of said scale inhibiting agent from said injection unit when a predetermined period of time passes after the start of said second injection step, and

the period of time t_a is set to be a period of time corresponding to an amount within a range of 0 times to 3 times as large as said retained water amount.

$t_a = mW / Q \quad ... (1)$

m: coefficient ($0 \leq m \leq 3$)

W: retained water amount (m^3)

Q: supplied water flow rate (m^3/h)

{Claim 10 ~~11~~}

A method for operating a de-ionization treatment device according to claim 4, comprising:

a de-ionization step of allowing supplied water containing ions to pass between a pair of opposing electrodes in a state in which one electrode is charged to be positive and the other electrode is charged to be negative, so as to allow negative ions to be adsorbed onto said one electrode and to allow positive ions to be adsorbed onto said other electrode, thereby to remove said ions from said supplied water;

a regeneration step of allowing said supplied water to pass between said electrodes in a state in which said one

electrode is charged to be negative and said other electrode is charged to be positive, so as to eliminate said negative ions from said one electrode to release said negative ions into said supplied water and to eliminate said positive ions from said other electrode to release said positive ions into said supplied water, thereby to regenerate said electrodes; and

a low ion concentration water feeding step of stopping said supplied water pump and said capacitive de-ionization treatment unit when the amount of water supplied to said capacitive de-ionization treatment unit is below or equal to a prescribed value or when the amount of treated water reaches a prescribed value and feeding said low ion concentration water in an amount based on the retained water amount of said de-ionization unit to said capacitive de-ionization treatment unit after the stop of said capacitive de-ionization treatment unit.

{Claim 11 ~~12~~}

A method for operating a de-ionization treatment device according to claim 5, comprising:

a de-ionization step of allowing supplied water containing ions to pass between a pair of opposing electrodes in a state in which one electrode is charged to be positive and the other electrode is charged to be negative, so as to allow negative ions to be adsorbed onto said one electrode and to allow positive ions to be adsorbed onto said other electrode, thereby to remove said ions from said supplied water;

a regeneration step of allowing said supplied water to pass between said electrodes in a state in which said one electrode is charged to be negative and said other electrode

is charged to be positive, so as to eliminate said negative ions from said one electrode to release said negative ions into said supplied water and to eliminate said positive ions from said other electrode to release said positive ions into said supplied water, thereby to regenerate said electrodes;

an addition step of adding a scale inhibiting agent into said supplied water; and

a low ion concentration water feeding step of feeding said low ion concentration water in an amount based on the retained water amount of said de-ionization unit to said capacitive de-ionization treatment unit after said capacitive de-ionization treatment unit is stopped, wherein

said addition step includes at least one of a regeneration-time addition step and a stoppage-time addition step,

said regeneration-time addition step includes:

a first injection step of injecting said scale inhibiting agent into said supplied water for a period of time t_a that is determined by formula (1) on the basis of a retained water amount of said de-ionization unit and a flow rate of said supplied water during said de-ionization step or simultaneously with the start of regeneration of said capacitive de-ionization treatment unit, and

a first injection stoppage step of stopping the injection of said scale inhibiting agent when a predetermined period of

time passes after the start of said first injection step or when a concentration of said ions in said supplied water discharged from said capacitive de-ionization treatment unit reaches a predetermined amount, ~~and~~

said stoppage-time addition step includes:

a second injection step of allowing injection of a predetermined amount of said scale inhibiting agent from said injection unit at the time of stoppage of said capacitive de-ionization treatment unit, and

a second injection stoppage step of stopping injection of said scale inhibiting agent from said injection unit when a predetermined period of time passes after the start of said second injection step, and

the period of time t_a is set to be a period of time corresponding to an amount within a range of 0 times to 3 times as large as said retained water amount.

$t_a = mW / Q \quad \ldots (1)$

m: coefficient ($0 \leq m \leq 3$)

W: retained water amount (m^3)

Q: supplied water flow rate (m^3/h)

~~{Claim 13}~~

~~The method for operating a de-ionization treatment device according to any of claims 8, 10, and 12, wherein the period of time during which said scale inhibiting agent is injected~~

~~in said de-ionization step is set to be a period of time corresponding to an amount within a range of 0 times to 3 times as large as said retained water amount.~~

{Claim 12 ~~14~~}

The method for operating a de-ionization treatment device according to claim 10 ~~11~~ or 11 ~~12~~, wherein said low ion

concentration water is fed in an amount corresponding to 3 times or more as large as said retained water amount.

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