{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 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 discharged water discharged from said capacitive de-ionization treatment unit becomes equal to or lower than the ion concentration that is permitted as treated water, 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.

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

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 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 discharged water discharged from said capacitive de-ionization treatment unit becomes equal to or lower than the ion concentration that is permitted as treated water, 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.

$t_a = mW / Q$ … (1)

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

W: retained water amount ($m^3$)

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

{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;

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 discharged water discharged from said capacitive de-ionization treatment unit becomes equal to or lower than the ion concentration that is permitted as treated water,

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,

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.

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

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

W: retained water amount ($m^3$)

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

{Claim 4}

The de-ionization treatment device according to claim 6, 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 5}

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 discharged water discharged from said capacitive de-ionization treatment unit becomes equal to or lower than the ion concentration that is permitted as treated water, 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}

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

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 injection 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 discharged water discharged from said capacitive de-ionization treatment unit becomes equal or lower than the Ion concentration that is permitted as treated water,

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.

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

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

W: retained water amount ($m^3$)

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

{Claim 7}

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;

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 injection 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 discharged water discharged from said capacitive de-ionization treatment unit becomes equal to or lower than the ion concentration that is permitted as treated water,

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.

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

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

W: retained water amount ($m^3$)

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

{Claim 8}

The method for operating a de-ionization treatment device according to claim 7, wherein said low ion concentration water is fed in an amount corresponding to 3 times or more as large as said retained water amount.