CLAIMS

[Claim 1]

A reverse osmosis device to be additionally installed in an existing seawater desalination plant which is provided with a pretreatment unit which treats sea water; a reverse osmosis membrane module to which the sea water treated by the pretreatment unit is supplied; a fresh water storage tank to which a filtered water membrane-separated by the reverse osmosis membrane module is supplied; and a concentrated water storage tank to which a concentrated water membrane-separated by the reverse osmosis membrane module is supplied,

wherein the reverse osmosis device is additionally installed between the pretreatment unit and the reverse osmosis membrane module,

the reverse osmosis device comprising:

in one container,

a plurality of first pressure vessels in which a plurality of reverse osmosis membrane elements are filled and are contained in parallel with one another;

a supply water connection pipe one end of which is connected to inlets of the first pressure vessels so as to supply pressurized supply water thereto;

wherein the supply water is membrane-separated into filtered water and high-pressure concentrated water by the

reverse osmosis membrane elements which are filled in the first pressure vessels, a concentrated water high-pressure connection pipe one end of which is connected to first outlets of the first pressure vessels and in which the high-pressure concentrated water passes and flows; and

a filtered water connection pipe one end of which is connected to second outlets of the first pressure vessels and in which the filtered water passes and flows,

wherein a supply water connection pipe connector which is provided on the other end of the supply water connection pipe, a concentrated water high-pressure connection pipe connector which is provided on the other end of the concentrated water high-pressure connection pipe, and a filtered water connection pipe connector which is provided on the other end of the filtered water connection pipe are arranged so as to locate on the same side face of the container,

outflows of the filtered water from the second outlets of the plurality of first pressure vessels join with one another by means of the filtered water connection pipe at a plurality of places, and the reverse osmosis device has a filtered water flow rate adjustment valve which is installed in the filtered water connection pipe between a place where the outflows of the filtered water from all the first pressure vessels join with one another

and the filtered water connection pipe connector,

the number of the reverse osmosis membrane elements which are filled in the first pressure vessel is smaller than the number of the reverse osmosis membrane elements which are filled in a pressure vessel which configures the reverse osmosis membrane module,

the concentrated water high-pressure connection pipe connector is connected to a supply water pipe connector which is provided on an inflow-side end of a supply water pipe which is connected to the reverse osmosis membrane module,

the sea water treated by the pretreatment unit is supplied to the reverse osmosis device via the supply water connection pipe connector,

the reverse osmosis device is provided with a high-pressure pump which is installed in the supply water connection pipe, wherein the supply water pressurized by the high-pressure pump is introduced thereinto through the inlets of the first pressure vessels via the supply water connection pipe,

the reverse osmosis device includes a filtered water energy recovery device which is installed in the filtered water connection pipe between the filtered water flow rate adjustment valve and the filtered water connection pipe connector, and

the filtered water energy recovery device supplies recovered energy to the high-pressure pump as an auxiliary of shaft power of the high-pressure pump.

[Claim 2]

A reverse osmosis device to be additionally installed in an existing seawater desalination plant which is provided with a pretreatment unit which treats sea water; a reverse osmosis membrane module to which the sea water treated by the pretreatment unit is supplied; a fresh water storage tank to which a filtered water membrane-separated by the reverse osmosis membrane module is supplied; and a concentrated water storage tank to which a concentrated water membrane-separated by the reverse osmosis membrane module is supplied,

wherein the reverse osmosis device is additionally installed between the pretreatment unit and the reverse osmosis membrane module,

the reverse osmosis device comprising:

in one container,

a plurality of first pressure vessels in which a plurality of reverse osmosis membrane elements are filled and are contained in parallel with one another;

a supply water connection pipe one end of which is connected to inlets of the first pressure vessels so as to supply pressurized supply water thereto;

wherein the supply water is membrane-separated into filtered water and high-pressure concentrated water by the reverse osmosis membrane elements which are filled in the first pressure vessels, a concentrated water high-pressure connection pipe one end of which is connected to first outlets of the first pressure vessels and in which the high-pressure concentrated water passes and flows; and

a filtered water connection pipe one end of which is connected to second outlets of the first pressure vessels and in which the filtered water passes and flows,

wherein a supply water connection pipe connector which is provided on the other end of the supply water connection pipe, a concentrated water high-pressure connection pipe connector which is provided on the other end of the concentrated water high-pressure connection pipe, and a filtered water connection pipe connector which is provided on the other end of the filtered water connection pipe are arranged so as to locate on the same side face of the container,

outflows of the filtered water from the second outlets of the plurality of first pressure vessels join with one another by means of the filtered water connection pipe at a plurality of places, and the reverse osmosis device has a filtered water flow rate adjustment valve which is installed in the filtered water connection pipe

between a place where the outflows of the filtered water from all the first pressure vessels join with one another and the filtered water connection pipe connector,

the number of the reverse osmosis membrane elements which are filled in the first pressure vessel is smaller than the number of the reverse osmosis membrane elements which are filled in a pressure vessel which configures the reverse osmosis membrane module,

the concentrated water high-pressure connection pipe connector is connected to a supply water pipe connector which is provided on an inflow-side end of a supply water pipe which is connected to the reverse osmosis membrane module,

the sea water treated by the pretreatment unit is supplied to the reverse osmosis device via the supply water connection pipe connector,

the reverse osmosis device is provided with a high-pressure pump which is installed in the supply water connection pipe, wherein the supply water pressurized by the high-pressure pump is introduced thereinto through the inlets of the first pressure vessels via the supply water connection pipe, and

outflows of the filtered water from the second outlets of the plurality of first pressure vessels join with one another by means of the filtered water connection

pipe at a plurality of places, wherein the reverse osmosis device has a filtered water energy recovery device which is installed in the filtered water connection pipe between a place where the outflows of the filtered water from all the first pressure vessels join with one another and the filtered water connection pipe connector.

[Claim 3]

A reverse osmosis device to be additionally installed in an existing seawater desalination plant which is provided with a pretreatment unit which treats sea water; a reverse osmosis membrane module to which the sea water treated by the pretreatment unit is supplied; a fresh water storage tank to which a filtered water membrane-separated by the reverse osmosis membrane module is supplied; and a concentrated water storage tank to which a concentrated water membrane-separated by the reverse osmosis membrane module is supplied,

wherein the reverse osmosis device is additionally installed between the pretreatment unit and the reverse osmosis membrane module,

the reverse osmosis device comprising:

in one container,

a plurality of first pressure vessels in which a plurality of reverse osmosis membrane elements are filled and are contained in parallel with one another;

a supply water connection pipe one end of which is connected to inlets of the first pressure vessels so as to supply pressurized supply water thereto;

wherein the supply water is membrane-separated into filtered water and high-pressure concentrated water by the reverse osmosis membrane elements which are filled in the first pressure vessels, a concentrated water high-pressure connection pipe one end of which is connected to first outlets of the first pressure vessels and in which the high-pressure concentrated water passes and flows; and

a filtered water connection pipe one end of which is connected to second outlets of the first pressure vessels and in which the filtered water passes and flows,

wherein a supply water connection pipe connector which is provided on the other end of the supply water connection pipe, a concentrated water high-pressure connection pipe connector which is provided on the other end of the concentrated water high-pressure connection pipe, and a filtered water connection pipe connector which is provided on the other end of the filtered water connection pipe are arranged so as to locate on the same side face of the container,

outflows of the filtered water from the second outlets of the plurality of first pressure vessels join with one another by means of the filtered water connection

pipe at a plurality of places, and the reverse osmosis device has a filtered water flow rate adjustment valve which is installed in the filtered water connection pipe between a place where the outflows of the filtered water from all the first pressure vessels join with one another and the filtered water connection pipe connector,

the number of the reverse osmosis membrane elements which are filled in the first pressure vessel is smaller than the number of the reverse osmosis membrane elements which are filled in a pressure vessel which configures the reverse osmosis membrane module,

the concentrated water high-pressure connection pipe connector is connected to a supply water pipe connector which is provided on an inflow-side end of a supply water pipe which is connected to the reverse osmosis membrane module,

the sea water treated by the pretreatment unit is supplied to the reverse osmosis device via the supply water connection pipe connector,

the supply water which is pressurized by a high-pressure pump which is installed outside the container is introduced thereinto through the inlets of the first pressure vessels via the supply water connection pipe, and

the reverse osmosis device includes a filtered water energy recovery device which is installed in the filtered

water connection pipe between the filtered water flow rate adjustment valve and the filtered water connection pipe connector.

[Claim 4]

The reverse osmosis device according to any one of claims 1 to 3,

wherein the inlet to which one end of the supply water connection pipe is connected is disposed on an approximately central part in a longitudinal direction of the first pressure vessel.

[Claim 5]

The reverse osmosis device according to any one of claims 1 to 4,

wherein the supply water connection pipe has a plurality of branches and one end thereof is connected to the inlets of the first pressure vessels via the branches, and

the concentrated water high-pressure connection pipe has a plurality of junctions where outflows of the high-pressure concentrated water from the first outlets of the plurality of first pressure vessels join with one another.

[Claim 6]

A seawater desalination plant comprising:

at least, a supply water pipe which supplies sea water which is treated by a pretreatment unit to a reverse

osmosis membrane module as supply water; the reverse osmosis membrane module which membrane-separates the supply water into filtered water and high-pressure concentrated water which is high-concentration saltwater; a filtered water pipe which supplies the filtered water to a fresh water storage tank; and a concentrated water pipe which supplies the high-pressure concentrated water to a concentrated water storage tank,

wherein a reverse osmosis device is additionally installed in the supply water pipe,

the reverse osmosis device includes, in one container, a plurality of first pressure vessels in which a plurality of reverse osmosis membrane elements are filled and are contained in parallel with one another, a supply water connection pipe one end of which is connected to inlets of the first pressure vessels so as to supply pressurized supply water thereto, wherein the supply water is membrane-separated into filtered water and high-pressure concentrated water by the reverse osmosis membrane elements which are filled in the first pressure vessels, a concentrated water high-pressure connection pipe one end of which is connected to first outlets of the first pressure vessels and in which the high-pressure concentrated water passes and flows, and a filtered water connection pipe one end of which is connected to second

outlets of the first pressure vessels and in which the filtered water passes and flows, wherein a supply water connection pipe connector which is provided on the other end of the supply water connection pipe, a concentrated water high-pressure connection pipe connector which is provided on the other end of the concentrated water high-pressure connection pipe, and a filtered water connection pipe connector which is provided on the other end of the filtered water connection pipe are arranged so as to locate on the same side face of the container, outflows of the filtered water from the second outlets of the plurality of first pressure vessels join with one another by means of the filtered water connection pipe at a plurality of places and the reverse osmosis device has a filtered water flow rate adjustment valve which is installed in the filtered water connection pipe between a place where the outflows of the filtered water from all the first pressure vessels join with one another and the filtered water connection pipe connector, the number of the reverse osmosis membrane elements which are filled in the first pressure vessel is smaller than the number of the reverse osmosis membrane elements which are filled in a pressure vessel which configures the reverse osmosis membrane module, the concentrated water high-pressure connection pipe connector is connected to a supply water

pipe connector which is provided on an inflow-side end of the supply water pipe which is connected to the reverse osmosis membrane module, and the sea water treated by the pretreatment unit is supplied to the reverse osmosis device via the supply water connection pipe connector,

wherein the supply water connection pipe connector is connected to a first connector which is provided on the supply water pipe, and the concentrated water high-pressure connection pipe connector is connected to a second connector which is provided on the supply water pipe and on the side of flowing into the reverse osmosis membrane module,

the filtered water connection pipe connector is connected to a branch pipe which is provided on the filtered water pipe or the other end of an extension pipe one end of which is connected to the fresh water storage tank,

the reverse osmosis device is provided with a high-pressure pump which is installed in the supply water connection pipe, wherein the supply water which is pressurized by the high-pressure pump is introduced through the inlet of the first pressure vessel via the supply water connection pipe,

the reverse osmosis device includes a filtered water energy recovery device which is installed in the filtered

water connection pipe between the filtered water flow rate adjustment valve and the filtered water connection pipe connector, and

the filtered water energy recovery device supplies recovered energy to the high-pressure pump as an auxiliary of shaft power of the high-pressure pump.

[Claim 7]

A seawater desalination plant comprising:

at least, a supply water pipe which supplies sea water which is treated by a pretreatment unit to a reverse osmosis membrane module as supply water; the reverse osmosis membrane module which membrane-separates the supply water into filtered water and high-pressure concentrated water which is high-concentration saltwater; a filtered water pipe which supplies the filtered water to a fresh water storage tank; and a concentrated water pipe which supplies the high-pressure concentrated water to a concentrated water storage tank,

wherein a reverse osmosis device is additionally installed in the supply water pipe,

the reverse osmosis device includes, in one container, a plurality of first pressure vessels in which a plurality of reverse osmosis membrane elements are filled and are contained in parallel with one another, a supply water connection pipe one end of which is connected

to inlets of the first pressure vessels so as to supply pressurized supply water thereto, wherein the supply water is membrane-separated into filtered water and high-pressure concentrated water by the reverse osmosis membrane elements which are filled in the first pressure vessels, a concentrated water high-pressure connection pipe one end of which is connected to first outlets of the first pressure vessels and in which the high-pressure concentrated water passes and flows, and a filtered water connection pipe one end of which is connected to second outlets of the first pressure vessels and in which the filtered water passes and flows, wherein a supply water connection pipe connector which is provided on the other end of the supply water connection pipe, a concentrated water high-pressure connection pipe connector which is provided on the other end of the concentrated water high-pressure connection pipe, and a filtered water connection pipe connector which is provided on the other end of the filtered water connection pipe are arranged so as to locate on the same side face of the container, outflows of the filtered water from the second outlets of the plurality of first pressure vessels join with one another by means of the filtered water connection pipe at a plurality of places and the reverse osmosis device has a filtered water flow rate adjustment valve which is

installed in the filtered water connection pipe between a place where the outflows of the filtered water from all the first pressure vessels join with one another and the filtered water connection pipe connector, the number of the reverse osmosis membrane elements which are filled in the first pressure vessel is smaller than the number of the reverse osmosis membrane elements which are filled in a pressure vessel which configures the reverse osmosis membrane module, the concentrated water high-pressure connection pipe connector is connected to a supply water pipe connector which is provided on an inflow-side end of the supply water pipe which is connected to the reverse osmosis membrane module, and the sea water treated by the pretreatment unit is supplied to the reverse osmosis device via the supply water connection pipe connector,

wherein the supply water connection pipe connector is connected to a first connector which is provided on the supply water pipe, and the concentrated water high-pressure connection pipe connector is connected to a second connector which is provided on the supply water pipe and on the side of flowing into the reverse osmosis membrane module,

the filtered water connection pipe connector is connected to a branch pipe which is provided on the filtered water pipe or the other end of an extension pipe

one end of which is connected to the fresh water storage tank,

the reverse osmosis device is provided with a high-pressure pump which is installed in the supply water connection pipe, wherein the supply water which is pressurized by the high-pressure pump is introduced through the inlet of the first pressure vessel via the supply water connection pipe, and

outflows of the filtered water from the second outlets of the plurality of first pressure vessels join with one another by means of the filtered water connection pipe at a plurality of places, wherein the reverse osmosis device has a filtered water energy recovery device which is installed in the filtered water connection pipe between a place where the outflows of the filtered water from all the first pressure vessels join with one another and the filtered water connection pipe connector.

[Claim 8]

A seawater desalination plant comprising:

at least, a supply water pipe which supplies sea water which is treated by a pretreatment unit to a reverse osmosis membrane module as supply water; the reverse osmosis membrane module which membrane-separates the supply water into filtered water and high-pressure concentrated water which is high-concentration saltwater;

a filtered water pipe which supplies the filtered water to a fresh water storage tank; and a concentrated water pipe which supplies the high-pressure concentrated water to a concentrated water storage tank,

wherein a reverse osmosis device is additionally installed in the supply water pipe,

the reverse osmosis device includes, in one container, a plurality of first pressure vessels in which a plurality of reverse osmosis membrane elements are filled and are contained in parallel with one another, a supply water connection pipe one end of which is connected to inlets of the first pressure vessels so as to supply pressurized supply water thereto, wherein the supply water is membrane-separated into filtered water and high-pressure concentrated water by the reverse osmosis membrane elements which are filled in the first pressure vessels, a concentrated water high-pressure connection pipe one end of which is connected to first outlets of the first pressure vessels and in which the high-pressure concentrated water passes and flows, and a filtered water connection pipe one end of which is connected to second outlets of the first pressure vessels and in which the filtered water passes and flows, wherein a supply water connection pipe connector which is provided on the other end of the supply water connection pipe, a concentrated

water high-pressure connection pipe connector which is provided on the other end of the concentrated water high-pressure connection pipe, and a filtered water connection pipe connector which is provided on the other end of the filtered water connection pipe are arranged so as to locate on the same side face of the container, outflows of the filtered water from the second outlets of the plurality of first pressure vessels join with one another by means of the filtered water connection pipe at a plurality of places and the reverse osmosis device has a filtered water flow rate adjustment valve which is installed in the filtered water connection pipe between a place where the outflows of the filtered water from all the first pressure vessels join with one another and the filtered water connection pipe connector, the number of the reverse osmosis membrane elements which are filled in the first pressure vessel is smaller than the number of the reverse osmosis membrane elements which are filled in a pressure vessel which configures the reverse osmosis membrane module, the concentrated water high-pressure connection pipe connector is connected to a supply water pipe connector which is provided on an inflow-side end of the supply water pipe which is connected to the reverse osmosis membrane module, and the sea water treated by the pretreatment unit is supplied to the reverse osmosis

device via the supply water connection pipe connector,

wherein the supply water connection pipe connector is connected to a first connector which is provided on the supply water pipe, and the concentrated water high-pressure connection pipe connector is connected to a second connector which is provided on the supply water pipe and on the side of flowing into the reverse osmosis membrane module,

the filtered water connection pipe connector is connected to a branch pipe which is provided on the filtered water pipe or the other end of an extension pipe one end of which is connected to the fresh water storage tank,

the reverse osmosis device is configured such that the supply water which is pressurized by a high-pressure pump which is installed outside the container is introduced thereinto through the inlets of the first pressure vessels via the supply water connection pipe, and

the reverse osmosis device has a filtered water energy recovery device which is installed in the filtered water connection pipe between the filtered water flow rate adjustment valve and the filtered water connection pipe connector.

[Claim 9]

The seawater desalination plant according to any one

of claims 6 to 8,

wherein the inlet to which one end of the supply water connection pipe is connected is disposed on an approximately central part in a longitudinal direction of the first pressure vessel.