

DESCRIPTION

TITLE OF THE INVENTION: SEAWATER DESALINATION SYSTEM AND SEAWATER DESALINATION METHOD

TECHNICAL FIELD

[0001]

The invention relates to a seawater desalination system and a seawater desalination method for desalinating seawater and sewage water.

BACKGROUND OF THE INVENTION

[0002]

Recently, global population increase and industrial development in many areas including emerging countries cause demand for producing drinking water and industrial water in a desert area and the like to become apparent.

A conventional system for desalinating seawater and sewage water provides a seawater desalination system S100 as shown in Fig. 6.

Production of product water s101 (industrial water) by use of sewage water in the seawater desalination system S100 is performed as follows. It is noted that the sewage water has a salt concentration of about 0.1 %.

[0003]

Sewage water is fed by a pump p101 to an MBR (Membrane Bioreactor) 101 to which a membrane separation is applied, and the activated sludge and the like are removed by the MBR 101. The MBR permeated water after passing through the MBR 101 is fed to a low-pressure RO membrane (Reverse Osmosis Membrane) 102 by a pump p102.

It is noted that the MBR permeated water, after passing through the MBR 101, has a low salt concentration of about 0.1 %, and the low-pressure RO membrane 102 employs an RO membrane for a low pressure of about 1 to 2 MPa (Mega Pascal).

[0004]

The MBR permeated water fed by the pump p102 passes through the low-pressure RO membrane 102 to be desalinated. Approximately a half of the MBR permeated water is produced as product water (industrial water) s101, and the

remaining half of it is separated and removed to be concentrate brine water s104 containing impurities such as salt components.

[0005]

The concentrate brine water s104 contains impurities such as salt components which are removed by the low-pressure RO membrane 102, is a concentrate with a salt concentration of about 0.2 %, and has about 1/2 volume of the sewage water. The concentrate brine water s104 is fed from the low-pressure RO membrane 102 to a stirring tank 104.

[0006]

Production of industrial water, which is product water s102 obtained from seawater in the seawater desalination system S100, is performed as follows. It is noted that the seawater has a salt concentration of about 3 to 4 %.

The seawater is fed by a pump p103 to the UF membrane (Ultrafiltration Membrane) 103 resulting in the particles in the seawater being removed by the UF membrane 103, and the resultant seawater is fed to a stirring tank 104. The stirring tank 104 has the UF membrane permeated seawater after passing through the UF membrane 103 stirred therein with the concentrate brine water s104 that is produced with about 1/2 volume of the sewage water by concentrating the sewage water through the low-pressure RO membrane 102. The stirred water is fed by a pump p104 to a middle-pressure RO membrane 105.

[0007]

The UF membrane permeated seawater after passing through the UF membrane 103, having a salt concentration of 3 to 4 %, is diluted by the concentrate brine water s104 with a salt concentration of about 0.2 %. Therefore, the middle-pressure RO membrane 105 employs an RO membrane (Reverse Osmosis Membrane) for a middle-pressure of about 3 to 5 MPa.

The mixed water s103, which is fed from the stirring tank 104 to the middle-pressure RO membrane 105 by the pump p104, passes through the middle-pressure RO membrane 105 to be desalinated. About 1/2 volume of the mixed water s103 is produced to be a desalinated product water s102 (industrial water), and the remaining 1/2 volume thereof is separated and removed to be brine water s105 containing impurities such as salt components. That is, the product water (industrial water) s102

is produced with 1/2 volume of the seawater and about 1/4 volume of the sewage water.

[0008]

That is, the brine water s105 is removed and discharged with 1/2 volume of the seawater and about 1/4 volume of the sewage water.

It is noted that pressure-energy of the brine water s105 is collected by the Energy Recovery Device 106 as rotation energy, and is used as power source (energy source) for feeding pressure on partial mixed water s103 bypassing the pump p104 to the middle-pressure RO membrane 105.

[0009]

Another conventional example provides a seawater desalination system S200 as shown in Fig. 7.

The seawater desalination system S200 is configured to independently perform desalination of sewage water and desalination of seawater, without feeding the concentrate brine water s104 in the seawater desalination system S100 in Fig.6 into the stirring tank 204.

[0010]

In the seawater desalination system S200, the seawater contains particles which are removed by the UF membrane 203, while the seawater is not diluted in the stirring tank 204 by water (concentrate brine water s104 of the sewage water in Fig. 6) fed from the sewage water, and thus has a high salt concentration of about 3 to 4 %. Therefore, the system employs a high-pressure RO membrane 205 that is an RO membrane (Reverse Osmosis Membrane) for a high pressure of about 6 to 8 MPa.

The seawater desalination system S200 has the sewage water pass through the low-pressure RO membrane 202 to be desalinated, and obtains product water s201 (industrial water) having about a half volume of the sewage water. On the other hand, the seawater contains particles which are removed by the UF membrane 203, and passes through the high-pressure RO membrane 205 to be desalinated, which obtains product water (drinking water) s203 having a 1/2 volume of the seawater.

The other components are the identical to those of the seawater desalination system S100 in Fig. 6, and the components of the seawater desalination system S100

are shown with the characters indicated by the 200s, and thus the detailed explanations are omitted.

[0011]

The conventional seawater desalination system S100 (refer to Fig. 6) has the following merits, compared with the seawater desalination system S200 (refer to Fig. 7).

[0012]

Firstly, the seawater desalination system S100 in Fig. 6 utilizes the discharged water (concentrate brine water s104), which is separated and removed in process of producing the product water s101 from the sewage water, for the process of producing the product water s102 from the seawater, and thus has a merit of increasing production amount of product water obtained from the seawater.

Specifically, if the discharged water (concentrate brine water s104) from the sewage water is not utilized, product water obtained from the seawater has about 1/2 volume of the seawater. On the other hand, increase by about 1/2 volume of the sewage water allows a lot of industrial water of the product water s102 to be obtained.

[0013]

Secondly, the concentrate brine water s104 (salt concentration of about 0.2 %) which is separated by the low-pressure RO membrane 102 from the sewage water is added to the seawater (salt concentration of about 3 to 4 %), and the seawater is diluted with the salt concentration lowered. Therefore, if the discharged water (concentrate brine water s104) from the sewage water is not utilized, the seawater having a high salt concentration requires the high-pressure RO membrane 205. On the other hand, dilution of the seawater by the concentrate brine water s104 allows for the use of the middle-pressure membrane 105, which lowers power of the pump p104, as compared with the use of the high-pressure RO membrane 205.

[0014]

This is because the middle-pressure RO membrane has a permeation pressure of about 3 to 5 MPa, while the high-pressure RO membrane has a permeation pressure of about 6 to 8 MPa. Therefore, passing through the high-pressure membrane requires a larger power (energy) than passing through the middle-pressure RO membrane requires.

It is noted that the prior art document related to the present invention is a Patent Document 1.

PRIOR ART DOCUMENT

PATENT DOCUMENT

[0015]

PATENT DOCUMENT 1: Japanese Patent Publication NO. 4481345.

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0016]

By the way, the conventional seawater desalination systems S100 and S200 have the following problems.

Firstly, the UF membrane and the RO membrane have permeation rates with high temperature dependency on permeation liquid.

The seawater desalination systems S100 and S200 desalinate seawater, while the seawater occasionally has low temperatures according to countries or regions. In this case, in the seawater desalination system S100, seawater with a low temperature causes a permeation rate of the seawater through the UF membrane 103 or the middle-pressure membrane 105 to be lowered due to a rise of the viscosity or the like. Therefore, permeating of low-temperature seawater through the UF membrane 103 or the middle-pressure membrane 105 requires additional power of the pumps p103 and p104, which causes the power to become larger.

[0017]

Similarly, in the seawater desalination system S200, seawater with a low temperature causes a permeation rate of the seawater through the UF membrane 203 or the high-pressure RO membrane 205 to be lowered. Therefore, permeation of the low-temperature seawater through the UF membrane 203 or the high-pressure RO membrane 205 requires additional power of the pumps p203 and p204, which causes the power to become larger.

[0018]

Secondly, the concentrate brine water s104, which is separated by the low-pressure RO membrane 102 in the seawater desalination system S100, is pressurized by the pump p102, while pressure energy of the concentrate brine water s104 is not

utilized. Similarly, the brine water s202, which is separated by the low-pressure membrane 202 in the seawater desalination system S200, is pressurized by the pump p202, while pressure energy of the brine water s 202 is not utilized. Therefore, it is difficult to say that the energy is efficiently utilized.

[0019]

Thirdly, the seawater desalination systems S100 and S200 include four pumps, respectively, which requires production cost of the pumps, installation cost, maintenance cost and the like, probably causing the cost increase.

[0020]

It is an object of the invention to provide a seawater desalination system and a seawater desalination method, which efficiently utilize energy and achieve inexpensive energy cost.

MEANS FOR SOLVING THE PROBLEM

[0021]

In order to achieve the object, a seawater desalination system according to Claim 1 is a seawater desalination system for desalinating seawater and sewage water, and includes a heat exchanger for performing heat exchange between the seawater and the sewage water or treated water of the sewage water.

A seawater desalination method according to Claim 6 fulfills the seawater desalination system according to Claim 1.

[0022]

A seawater desalination system according to Claim 2 is a seawater desalination system for desalinating seawater and sewage water. The system includes a membrane separation bioreactor treatment system for treating the sewage water by a membrane separation bioreactor; a first RO membrane having permeated water after passing through the membrane separation bioreactor treatment system permeate therethrough to remove from the permeated water salt components to be contained in first concentrate brine water, thereby producing industrial water; a UF membrane having the seawater permeate therethrough to remove particles contained in the seawater; a second RO membrane having treated water after passing through the UF membrane permeate therethrough to remove from the treated water salt components to be contained in second concentrate brine water, thereby producing drinking water; and

a heat exchanger for performing heat exchange between the seawater and the sewage water or treated water of the sewage water.

A seawater desalination method according to Claim 7 fulfills the seawater desalination system according to Claim 2.

ADVANTAGEOUS EFFECT OF THE INVENTION

[0023]

According to the seawater desalination system and the seawater desalination method of the invention, the seawater desalination system and the seawater desalination method, which efficiently utilize energy and achieve inexpensive energy cost, are fulfilled.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024]

Fig.1 is a conceptual configuration view of a seawater desalination system of a first embodiment according to the invention;

Figs. 2A, 2B and 2C are conceptual views showing variations of the heat exchanger in the seawater desalination system of the first embodiment, where Fig. 2A is a conceptual view showing a heat exchanger for performing heat exchange by feeding seawater to the flow passage of sewage water, Fig. 2B is a conceptual view showing a heat exchanger for performing heat exchange by feeding sewage water to the flow passage of seawater, and Fig. 2C is a conceptual view showing a heat exchanger for performing heat exchange by feeding heat medium to the flow passage of sewage water and the flow passage of seawater;

Fig. 3 is a view showing the positions for heat exchange with sewage water in the seawater desalination system according to the first embodiment;

Fig. 4 is a conceptual configuration view showing a seawater desalination system according to a second embodiment;

Fig. 5 is a conceptual configuration view showing a seawater desalination system according to a third embodiment;

Fig. 6 is a conceptual configuration view showing a conventional seawater desalination system; and

Fig. 7 is a conceptual configuration view showing another conventional seawater desalination system.

EMBODIMENTS CARRYING OUT THE INVENTION

[0025]

Embodiments of the invention are hereinafter described with reference to the drawings.

<<First Embodiment>>

Fig. 1 is a conceptual configuration view of a seawater desalination system of a first embodiment according to the invention.

The seawater desalination system S of the first embodiment includes, for producing industrial water s1 from sewage water, an MBR (Membrane Bioreactor) 1 for treating the sewage water by a membrane separation bioreactor; and a low-pressure RO membrane (Reverse Osmosis Membrane) 2 for removing impurities such as salt components or ions contained in the sewage water for desalination.

[0026]

The MBR 1 performs solid-liquid separation, and separates and removes an activated sludge from the sewage water.

The RO membrane (Reverse Osmosis Membrane) is a semipermeable membrane which has water pass therethrough and which makes it difficult for low molecular materials such as salt components or ions to pass therethrough. The sewage water has a low salt concentration of about 0.1 %, and the low-pressure RO membrane 2 serves as an RO membrane for low-pressure which removes salt components or the like under a relatively low permeation pressure of about 1 to 2 MPa (Mega Pascal).

[0027]

The seawater desalination system S includes, for producing drinking water s2 from seawater, a UF membrane (Ultrafiltration Membrane) 3 which removes particles contained in the seawater. The system S includes a stirring tank 4 having the seawater stirred to be uniformed, the seawater after passing through the UF membrane 3 to have the particles removed therefrom. The system S includes a high-pressure RO membrane 5 which removes impurities such as salt components or ions contained in the seawater for desalination, the seawater after having particles removed therefrom and being stirred in the stirring tank 4. It is noted that the stirring tank 4 also has a function to reserve the seawater to be fed to the pump p4 for enabling the pump p4 to be stably operated.

[0028]

The UF membrane (Ultrafiltration Membrane) 3 has seawater permeate therethrough, having so small pores as to be comparable to molecular sizes of objective materials to be removed from the seawater and capable of filtering at molecular level, and thereby removing the particles contained in the seawater.

The seawater has a salt concentration of about 3 to 4 %, and the high-pressure RO membrane 5 is an RO membrane for high-pressure which removes salt components and the like under a relatively high permeation pressure of about 6-8 MPa (Mega Pascal).

[0029]

By the way, sewage water used in the seawater desalination system S flows underground, and is relatively warm at a temperature of about 15 to 20 degree Celsius, for example, in a temperate zone area. On the other hand, seawater used in the seawater desalination system S is exposed to the atmosphere, and has a tendency to be subjected to influence of climatic change. That is, the tendency to be subjected to an influence of climatic change causes the seawater to occasionally have a low temperature of about 10 degree Celsius in early autumn.

As described above, the UF membrane 3 and the high-pressure RO membrane 5 used for desalinating the seawater have high dependency on the temperature of permeation liquid. These membranes 3 and 5 tend to have low permeation rates under low temperatures, while having high permeation rates under high temperatures.

[0030]

Therefore, the seawater desalination system S includes a heat exchanger 6 for performing heat exchange to give heat of the sewage water to the seawater. Specifically, the heat exchanger 6 performs heat exchange between the sewage water, which flows through the flow passage r11 disposed upstream of the MBR 1 on the passage for desalinating sewage water, and the seawater, which flows through the flow passage r2 disposed upstream of the UF membrane 3 on the passage for desalinating the seawater, thereby giving heat of the sewage water to the seawater by the heat exchange.

[0031]

The heat exchanger 6 may be constructed with the following various embodiments.

Fig. 2A, 2B and 2C are conceptual views showing variations of the heat exchanger in the seawater desalination system. Fig. 2A is a conceptual view showing a heat exchanger for performing heat exchange by flowing of the seawater through the flow passage of the sewage water. Fig. 2B is a conceptual view showing a heat exchanger for performing heat exchange by flowing of the sewage water through the flow passage of seawater. Fig. 2C is a conceptual view showing a heat exchanger for performing heat exchange by flowing of heat medium through the flow passage of the sewage water and the flow passage of the seawater.

The heat exchanger 6A as shown in Fig. 2A is constructed in such a way that flowing of the seawater within the flow passage r2 disposed upstream of the UF membrane 3 into the flow passage r11 of the sewage water disposed upstream of the MBR 1 provides the seawater with heat of the sewage water by the heat exchange.
[0032]

The heat exchanger 6B as shown in Fig. 2B is constructed in such a way that flowing of the sewage water in the flow passage r11 disposed upstream of the MBR 1 into the flow passage r2 of the seawater disposed upstream of the UF membrane 3 provides the seawater with heat of the sewage water by the heat exchange.

The heat exchanger 6C as shown in Fig. 2C is constructed in such a way that circulating of the heat medium n of easily heat transferable liquid into the flow passage r11 disposed upstream of the MBR 1 and the flow passage r2 disposed upstream of the UF membrane 3 by the pump p9 provides heat of the sewage water in the flow passage r11 disposed upstream of the MBR 1 to be carried by the heat medium n to the seawater in the flow passage r2 disposed upstream of the UF membrane 3.

These are heat exchangers 6A, 6B and 6C referred to as a shell and coil type or a shell and tube type.
[0033]

It is noted that Fig. 1 shows by example the case where the heat exchanger 6 is located downstream of the pump p1 on the flow passage r11 of the sewage water and downstream of the pump p3 on the flow passage r2 of the seawater. Alternatively,

the heat exchanger 6 may be located without being limited to the upstream or downstream of the pump P1 on the flow passage r11 of the sewage water. The heat exchanger 6 may be located without being limited to the upstream or downstream of the pump p3 on the flow passage r2 of the seawater.

In the case of the heat exchanger 6A in Fig. 2A, the downstream of the pump p3 on the flow passage r2 of the seawater (refer to Fig. 1) is more preferable because pressure feeding power by the seawater to the flow passage r11 of the sewage water (pressure feeding power to a coil or the like located in the flow passage r11) is obtained. In this case, the heat exchanger 6A may be located upstream or downstream of the pump p1 on the flow passage r11 of the sewage water.

[0034]

Similarly, in the case of the heat exchanger 6B in Fig. 2B, the downstream of the pump p1 on the flow passage r11 of the sewage water (refer to Fig. 1) is more preferable due to obtaining pressure feeding power of the sewage water to the flow passage r2 of the seawater. In this case, the heat exchanger 6B may be located upstream or downstream of the pump p3 on the flow passage r2 of seawater.

It is noted that the heat exchanger 6 may be selected for use from any type of a counterflow heat exchanger, a parallel flow heat exchanger and a crossflow heat exchanger.

[0035]

Fig. 3 is a view of the seawater desalination system in which the positions for heat exchange between sewage water and seawater are shown.

In the seawater desalination system S, the position for heat exchange between the sewage water and the seawater may be the position A disposed upstream of the MBR 1 on the flow passage r11 of the sewage water, the position B on the flow passage r12 after passing through the MBR 1, the position C on the flow passage r13 of the brine water s6 which is removed by the low-pressure RO membrane 2, or the position D on the flow passage r14 after passing through the low-pressure RO membrane 2.

The sewage water, however, has a large storage of heat on the upstream side of the flow passage of the sewage water, and the position A, the position B, the

position C, and the position D on the upstream side are thermally preferable in that order.

[0036]

The following description is given of the process for producing industrial water s1 from sewage water in the seawater desalination system S as shown in Fig. 1.

The sewage water is pressurized into the seawater desalination system S by the pump p1. The sewage water is heat exchanged with the seawater flowing in the flow passage r2 through the heat exchanger 6 to provide the seawater with heat, and is fed to the MBR 1. The sewage water passes through the MBR 1 with the activated sludge flock, bacteria and the like removed.

[0037]

The MBR permeated water s5a after passing through the MBR 1 is fed to the low-pressure RO membrane 2 by the pump p2. The MBR permeated water s5a passes through the low-pressure RO membrane 2 with the brine water s6 containing impurities such as salt components or ions removed for desalination, thereby producing the industrial water s1.

The industrial water s1 is obtained by about 1/2 volume of the sewage water, while the residue of the sewage water, or about 1/2 volume of the sewage water, is removed to be the brine water s6 containing impurities such as salt components or ions.

[0038]

The following description is given of the process for producing drinking water s2 as product water from the seawater in the seawater desalination system S.

The seawater is pressurized into the seawater desalination system S by the pump p3. The seawater is heated with heat of the sewage water through the heat exchanger 6 to be fed to the UF membrane 3. The seawater heated by the heat exchanger 6 passes through the UF membrane 3 with the particles removed from the seawater. The UF membrane permeated seawater s5b from which the particles have been removed by the UF membrane 3 is stirred in the stirring tank 4 to be uniform.

[0039]

The stirred UF membrane permeated seawater s5b is fed to the high-pressure RO membrane 5 by the pump p4. The UF membrane permeated seawater s5b passes through the high-pressure RO membrane 5 with approximately a half thereof removed

to be the brine water s7 containing impurities such as salt components or ions and with the remaining half thereof produced to be the desalinated drinking water s2.

[0040]

According to the seawater desalination system S of the first embodiment, the heat exchanger 6 takes heat of the sewage water higher in temperature than seawater to heat the seawater of a lower temperature. The heated seawater easily and preferably passes through respectively the UF membrane 3 and the high-pressure RO membrane 5.

This leads to a reduction in respective powers for the pumps p3 and P4 for pressure feeding the seawater, and to achievement of energy saving of the seawater desalination system S.

[0041]

<<Second Embodiment>>

Fig. 4 is a conceptual configuration view showing a seawater desalination system according to a second embodiment.

The seawater desalination system 2S according to the second embodiment includes an energy recovery device 21 which collects pressure energy of the brine water s6 in the seawater desalination system S of the first embodiment.

The other components are the identical to those of the seawater desalination system S of the first embodiment, the identical components are shown with the same characters as in the first embodiment, and thus the detailed explanation thereof is omitted.

[0042]

The seawater desalination system 2S includes the energy recovery device 21 which collects pressure energy of the brine water s6 removed by the low-pressure RO membrane 2 as electric energy or rotation energy (mechanical energy).

The energy recovery device 21 collects mechanical energy as electric energy (electric power), for example, by small-scale hydroelectric power generation with a water wheel, a gear wheel or the like using pressure energy of the brine water s6. Electric power collected by the energy recovery device 21 is used as electric power of the pump p3 which pressure feeds the seawater to the UF membrane 3 (as indicated by

the broken line in Fig. 4). It is noted that the collected electric power may be not used as electric power for the pump p3, but as electric power for another.

[0043]

Alternatively, the energy recovery device 21 may collect pressure energy as rotation energy (mechanical energy), which is given the sea water flowing through the UF membrane 3, and the pump p3 may be omitted.

If the rotation energy (mechanical energy) collected by the energy recovery device 21 is not so large, a pump p3 may be provided to reduce the power of the pump p3.

Alternatively, the energy recovery device 21 using the well-known pressure direct conversion method may be configured to give the pressure of the brine water s6 directly to the seawater flowing through the UF membrane 3.

It is noted that the rotation energy (mechanical energy) or pressure energy collected by the energy recovery device 21 may not be given to the seawater flowing through the UF membrane 3, but may be applied to another position.

[0044]

According to the second embodiment, the energy recovery device 21 collects the pressure energy of the brine water s6, which achieves energy saving. This reduces the energy cost.

It is noted that the seawater desalination system 2S of the second embodiment shows by example the case of provision of the heat exchanger 6, but the heat exchanger 6 may be omitted in an area having seawater with a high temperature.

[0045]

<<Third Embodiment>>

Fig. 5 is a conceptual configuration view showing a seawater desalination system according to a third embodiment.

The seawater desalination system 3S of the third embodiment is configured in such a way that the brine water s6, which is separated by the low-pressure RO membrane 2 of the seawater desalination system S according to the first embodiment, joins the flow passage r2 of the seawater.

The other components are the identical to those of the seawater desalination system S of the first embodiment, the identical components are shown with the same

characters as in the first embodiment, and thus the detailed explanation thereof is omitted.

[0046]

The seawater desalination system 3S has the brine water s6, which is separated by the low-pressure RO membrane 2, join the flow passage r2 of the seawater, and obtains pressure feeding power to the UF membrane 3 using the pressure energy of the brine water s6. Therefore, the pump 3 is omitted.

In this case, the product water s9 obtained from the seawater becomes industrial water. It is noted that the product water s9 may be used as drinking water.

[0047]

According to the seawater desalination system 3S of the third embodiment, omission of the pump p3 eliminates production cost, installation cost, maintenance cost and the like of the pump p3, thereby achieving a lower cost.

It is noted that if the pressure energy of the brine water s6 is not so large and the pressure feeding power by the seawater to the UF membrane 3 is insufficient, the pump 3 may be provided. In this case, reduction in power of the pump p3 achieves energy saving. This reduces the energy cost.

It is noted that the seawater desalination system 3S of the third embodiment shows by example the case of providing the heat exchanger 6, but the heat exchanger 6 may be omitted in an area having seawater with a high temperature.

[0048]

<<Other Embodiments>>

The first to third embodiments show by example the cases of desalinating the sewage water and the seawater to produce the industrial water and the drinking water, respectively. On the other hand, the invention is applicable to the case of desalinating the sewage water and the seawater to produce the industrial water without producing drinking water. For example, the invention is applicable to the case where a portion of the sewage water in Fig 7 flows into the passage for desalinating seawater for producing industrial water.

Thus, the invention is widely applicable to a system for desalinating sewage water and seawater, respectively.

EXPLANATION OF CHARACTERS

[0049]

1: MBR (Membrane Bioreactor)

2: low-pressure RO membrane (first RO membrane)

3: UF membrane

5: high-pressure RO membrane (second RO membrane)

6, 6A, 6B, 6C: heat exchanger

21: energy recovery device

S, 2S, 3S: seawater desalination system

s1: industrial water (treated water of sewage water)

s2: drinking water

s5a: MBR permeated water (permeated water, treated water of sewage water)

s5b: UF membrane permeated seawater (treated water)

s6: brine water (first concentrate brine water, treated water of sewage water)

s7: brine water (second concentrate brine water)

CLAIMS

WHAT IS CLAIMED IS:

1. A seawater desalination system for desalinating seawater and sewage water, the system comprising: a heat exchanger for performing heat exchange between the seawater and the sewage water or treated water of the sewage water.
2. The seawater desalination system for desalinating seawater and sewage water, the system comprising:
 - a membrane separation bioreactor treatment system for treating the sewage water by a membrane separation bioreactor;
 - a first RO membrane having permeated water after passing through the membrane separation bioreactor treatment system permeate therethrough to remove from the permeated water salt components to be contained in a first concentrate brine water, thereby producing industrial water;
 - a UF membrane having the seawater permeate therethrough to remove particles contained in the seawater;
 - a second RO membrane having treated water after passing through the UF membrane permeate therethrough to remove from the treated water salt components to be contained in second concentrate brine water, thereby producing drinking water; and
 - a heat exchanger for performing heat exchange between the seawater and the sewage water or treated water of the sewage water.
3. The seawater desalination system according to Claim 2,
 - wherein the heat exchanger performs heat exchange between the seawater being at the upstream of the UF membrane and any one of the sewage water being at the upstream of the membrane separation bioreactor treatment system, the permeated water after passing through the membrane separation bioreactor treatment system, the first concentrate brine water and the produced industrial water.
4. The seawater desalination system according to Claim 2 or Claim 3, further comprising: an energy recovery device for collecting pressure energy from the first concentrate brine water.

5. The seawater desalination system according to Claim 2 or Claim 3,
wherein the first concentrate brine water joins the seawater being at the upstream of the UF membrane.
6. A seawater desalination method for desalinating seawater and sewage water comprising:
performing heat exchange between the seawater and the sewage water or treated water in process of desalinating the sewage water.
7. A seawater desalination method for desalinating seawater and sewage water comprising:
performing heat exchange between the seawater and the sewage water or treated water in process of desalinating the sewage water;
having the sewage water permeate through a membrane separation bioreactor treatment system and a first RO membrane to produce industrial water; and
having the seawater permeate through a UF membrane and a second RO membrane to produce drinking water.
8. The seawater desalination method according to Claim 7, further comprising:
collecting pressure energy from first concentrate brine water removed by the first RO membrane.
9. The seawater desalination method according to Claim 7, further comprising:
joining first concentrate brine water removed by the first RO membrane to the seawater being at the upstream of the UF membrane.