water.

BRIEF DESCRIPTION OF DRAWINGS

[0020]

FIG. 1 is a flow diagram illustrating the method for operating the desalting device according to an embodiment.

FIG. 2 is a flow diagram illustrating the method for operating the desalting device according to an embodiment.

FIG. 3 is a flow diagram illustrating the method for operating the desalting device according to an example.

FIG. 4 is a flow diagram illustrating the method for operating the desalting device according to an example.

FIG. 5 is a graph showing the results of the example and the comparative example.

DESCRIPTION OF EMBODIMENTS

[0021] The first embodiment is described below with reference to FIG. 1 and FIG. 2. In this embodiment, a reverse osmosis membrane device (RO device) is taken as an example of the desalting device, but the present invention is not limited thereto. It is noted that the reverse osmosis membrane is preferably an aromatic polyamide reverse osmosis membrane, but is not limited thereto. Examples of desalting devices other than reverse osmosis membrane devices include nanofiltration membrane devices, forward osmosis membrane devices, membrane distillation devices, electrodialysis devices, and electrodeionization devices. Further, examples of water to be treated include industrial water with a salt concentration of about 10 to 5000 mg/L, particularly about 50 to 1000 mg/L, well water, fluoride-containing waste water, and the like, but

supply port of the second desalting device 22 via the pipes 43 and 40, and the second desalting device 22 is caused to be in the dilute water passing operation.

[0029] During the dilute water passing operation of the other second RO device 22, the desalted water from the other second RO device 22 is merged into the pipe 33 via the pipes 73 and 62 and taken out as desalted water. The concentrated water from the second RO device 22 is returned to the raw water tank 1 via pipes 74 and 77, a valve 78, and pipes 79 and 71.

[0030] [During operation of FIG. 2]

Contrary to FIG. 1, in FIG. 2, the one second desalting device 21 is in the dilute water passing operation, and the other second desalting device 22 is in the normal operation. In this case as well, raw water in the raw water tank 1 is supplied to the first RO device 4 via the pump 2 and the pipe 3, and desalted water (permeated water) is taken out as desalted water via the pipe 31, the valve 32, and the pipe 33.

[0031] In FIG. 2, the valve 36 is closed and the valve 39 is open. Thus, the concentrated water from the first RO device 4 (first concentrated water) is supplied to the other second RO device 22 via the pipes 34 and 38, the valve 39, and the pipe 40.

[0032] The desalted water (permeated water) from the second RO device 22 is merged into the pipe 33 via the pipes 73 and 62 and taken out as desalted water. The concentrated water from the second RO device 22 flows through the pipes 74 and 75 and the valve 76 into the pipe 65, and is taken out as concentrated water.

[0033] In addition, in FIG. 2, the valve 42 is open and the valve 44 is closed. Thus, a part of the first desalted water from the pipe 31 is supplied to the water supply port of the one second desalting device 21 via the pipes 41 and 37, and the second desalting device 21 is caused to be in the dilute water passing operation. The desalted water from the one second RO device 21 is merged into the pipe 33 via the pipes 61 and 62 and taken out as desalted water. The concentrated water from the one second RO device 21 is returned to the raw water tank 1 via the pipes 63 and

ΔP_{fba}: Module differential pressure (kPa) under actual operating conditions

P_{pa}: Pressure (kPa) on the permeated water side under actual operating conditions

π_{fba}: Osmotic pressure (kPa) of the average solute concentration on the supply side and the concentrated side under actual operating conditions

TCF_a: Temperature conversion coefficient under actual operating conditions

P_{fs}: Operating pressure (kPa) under standard operating conditions

ΔP_{fbs}: Module differential pressure (kPa) under standard operating conditions

P_{ps}: Pressure (kPa) on the permeated water side under standard operating conditions

π_{fbs}: Osmotic pressure (kPa) of the average solute concentration on the supply side and the concentrated side under standard operating conditions

TCF_s: Temperature conversion coefficient under standard operating conditions

[0053] <Desalting device configuration in FIG. 3 and FIG. 4>

Raw water in a raw water tank 81 may be feed via a pump 82 and pipe 83. The pipe 83 branches into pipes 84 and 85, which are connected to first RO devices 86 and 87. The permeated water from the first RO devices 86 and 87 may be taken out as desalted water via pipes 88 and 89 and a joint pipe 90.

[0054] The concentrated water from the first RO devices 86 and 87 is supplied to a second RO device 94 via pipes 91 and 92 and a joint pipe 93. The permeated water from the second RO device 94 flows through a pipe 95 and joins the pipe 90. The concentrated water from the second RO device 94 is discharged outside the system via a pipe 96.

[0055] The dilute water in a dilute water tank 97 may be supplied to the second RO device 94 via a pump 98, a pipe 99 and the pipe 93. In this test example, the above desalted water was used as the dilute water.

[0056] FIG. 3 shows a normal raw water treatment operation with the pump 82 operating and the pump 98 stopped. The raw water is subjected to RO treatment in the first RO device 86 and 87 or further in the second RO device 94, and separated into permeated water (desalted water) and concentrated water.

[0057] FIG. 4 shows a state in which the dilute water is passed through the second RO device 94. In FIG. 4, the pump 82 is stopped, only the pump 98 is operated, and the supply of raw water to the first RO devices 86 and 87 is stopped. The dilute water in the dilute water tank 97 is passed through the second RO device 94, whereby scale of the second RO device 94 is dissolved and removed.

[0058] It is noted that in FIG. 4, the permeated water is not allowed to flow into the pipe 95 while the dilute water is being passed through the second RO device 94. However, the permeated water may be allowed to flow into the pipe 95 while the dilute water is being passed through the second RO device 94.

[0059] <Simulated raw water>

As a simulated raw water, an aqueous solution containing calcium chloride (110 mg/L), sodium bicarbonate (70 mg/L), sodium metasilicate (1610 mg/L), aluminum chloride hexahydrate (0.45 mg/L), ferric chloride (0.4 mg/L), and a scale inhibitor (2-phosphonobutane-1,2,4-tricarboxylic acid) (10 mg/L) was prepared, and further, the pH was adjusted to 5.5 with an aqueous sodium hydroxide solution or an aqueous sulfuric acid solution (water temperature 20°C).

[0060] <Dilute water>

As the dilute water, the permeated water obtained when the simulated raw water was passed through the RO device as shown in FIG. 3 was used. The scale inhibitor was added at 10 mg/L.

[0061] [Example 1]

The above-mentioned simulated raw water and simulated dilute water were passed through the desalting device of FIG. 3 and FIG. 4.