exceeds an allowable value determined from an allowable urea concentration for the ultrapure water, the second raw water is introduced into a urea decomposition apparatus, to adjust the urea concentration to the allowable value or lower.

[0012] By this ultrapure water production method, in a case in which the urea concentration in the second raw water exceeds the allowable value determined from the allowable urea concentration for ultrapure water, the second raw water is introduced into the urea decomposition apparatus to adjust the urea concentration to the allowable value or lower, and is then merged with the raw water using clean water. Thus, sewage water can be more effectively utilized.

[0013] An ultrapure water production system according to a fourth aspect includes: a pretreatment unit that obtains pretreated water by removing suspended substances from raw water containing clean water; a primary treatment unit that produces primary pure water by removing all organic carbon components and ionic components from the pretreated water; a secondary treatment unit that produces ultrapure water by removing impurities from the primary pure water; and a urea meter that measures a urea concentration in second raw water containing sewage treatment water, wherein the second raw water having a urea concentration equal to or lower than an allowable value is merged with the raw water or the pretreated water at an upstream side of the primary treatment unit.

[0014] In this ultrapure water production system, the second raw water that contains drainage water from a sewage treatment plant and has a urea concentration equal to or lower than the allowable value, in addition to raw water using clean water, is used to produce ultrapure water. Accordingly, the proportion of the clean water in the raw water to be used in the ultrapure water production can be lowered.

[0015] A fifth aspect is the ultrapure water production system according to the fourth aspect, which further includes a urea decomposition unit that includes a urea decomposition apparatus that decomposes urea in the second raw water, and that introduces the second raw water into the urea decomposition apparatus to lower the urea concentration in a case in which the urea concentration exceeds an allowable value determined from an allowable urea concentration for the ultrapure water.

[0016] In this ultrapure water production system, in a case in which the urea concentration in the second raw water exceeds the allowable value determined from the allowable urea concentration for ultrapure water, the second raw water is introduced into the urea decomposition apparatus to adjust the urea concentration to the allowable value or lower, and is then merged with the raw water using clean water. Thus, sewage water can be more effectively utilized.

[0017] A sixth aspect is the ultrapure water production system according to the fourth aspect or the fifth aspect, in which an amount of the second raw water to be merged with the raw water or the pretreated water is configured such that a weighted average of a urea concentration in the raw water or the pretreated water and the urea concentration in the second raw water becomes equal to or lower than an allowable value determined from an allowable urea concentration for the ultrapure water.

[0018] In this ultrapure water production system, the amount of the second raw water to be merged with the raw water is set depending on the urea concentration determined from the allowable urea concentration for the ultrapure water, and thus, the urea concentration in the ultrapure water can be restricted to be equal to or lower than the standard.

Advantageous Effects of Invention

[0019] According to the disclosure, the proportion of clean water in the raw water to be used in ultrapure water production can be reduced.

BRIEF DESCRIPTION OF DRAWINGS

[0020] Fig. 1 is a block diagram showing an outline of an ultrapure water production system according to the present embodiment.

Fig. 2 is a block diagram showing an outline of an ultrapure water production system according to a modification of the present embodiment.

Fig. 3 is a block diagram showing an example configuration of a urea meter.

Fig. 4 is a line chart showing an example of a change in urea concentration in second raw water over time, and conditions for acceptance of the second raw water.

DESCRIPTION OF EMBODIMENTS

[0021] In the following, modes for carrying out the disclosure will be described with reference to the drawings. Components denoted by the same reference numerals in the respective drawings are the same or similar components. Note that repetitive descriptions and reference numerals in the embodiments described below will be omitted in some cases. Further, all of the drawings used in the following description are schematic, and the dimensional relationships among the respective elements, the proportions of the respective elements, and the like illustrated in the drawings do not necessarily coincide with actual ones. Furthermore, the dimensional relationships among the respective elements, the proportions of the respective elements, and the like are not necessarily the same between the drawings.

[0022] In the following, modes for carrying out the disclosure will be described with reference to the drawings.

line 28.

[0027] The second raw water is water containing sewage treatment water obtained by subjecting sewage water 24 to a biological treatment step 27 at a sewage treatment plant 26. The second raw water having a urea concentration equal to or lower than an allowable value determined from the allowable urea concentration for ultrapure water joins the raw water or the pretreated water at the upstream side of the primary treatment unit 11. In the example illustrated in Fig. 1, the second raw water joins the raw water and is stored in a raw water tank 20. In a modification illustrated in Fig. 2, the second raw water joins the pretreated water between the pretreatment unit 10 and the primary treatment unit 11. The pretreatment unit 10 is not an apparatus intended to remove urea, and the removal of suspended substances at the pretreatment unit 10 has already been performed at the sewage treatment plant. Therefore, the raw water and the second raw water may merge at the position shown in the modification illustrated in Fig. 2.

[0028] As the urea meter 30, one shown as an example in Fig. 3 that measures the urea concentration in the second raw water containing sewage treatment water can be used, for example. Here, the urea meter 30 includes a pretreatment apparatus 36 and a TOC meter 54. The pretreatment apparatus 36 is formed with an ultraviolet irradiation apparatus, a reverse osmosis membrane apparatus, or an ion-exchange apparatus, for example. Since the second raw water contains urea and TOC components other than urea, the TOC components other than urea are removed. The TOC meter 54 includes a decarbonation device 56, an ultraviolet oxidation device 58, a CO_2 detection device 60, and a CO_2 detection device 62. The TOC meter 54 is a device that measures the concentration of urea in the second raw water from which the TOC components other than urea have been removed, as TOC. Also, the measurement target liquid is not necessarily the second raw water that is sewage treatment water, and the second raw water treated by a urea decomposition apparatus 32, the ultrapure water obtained at the secondary treatment unit 12, or any other liquid obtained during each intermediate process in the ultrapure water production system 100 can be used as the measurement target liquid.

[0029] In the decarbonation device 56 of the TOC meter 54, a hollow fiber (vacuum degassing) module or the like is used to remove carbonic acid from the measurement target liquid, for example. Specifically, phosphoric acid is added to the measurement target liquid, and the measurement target liquid then permeates through a gas permeable membrane having its one side evacuated. Note that, in a case in which the concentration of carbonic acid in the measurement target liquid to be sent to the TOC meter 54 is low, and the influence on CO_2 detection is small, the removal of carbonic acid by the decarbonation device 56 may be skipped.

[0030] Alternatively, as the TOC meter 54, one without the decarbonation device 56 may be used. In this case, if it is necessary to remove carbonic acid from the measurement target liquid,

the decarbonation device 56 can be provided in front (on the upstream side) of the TOC meter 54, for example. Examples of such a decarbonation device 56 include degassing devices, and a vacuum degassing membrane, a degassing tower, a vacuum degassing tower, or the like can be a candidate, but a vacuum degassing membrane is preferable.

[0031] Before the measurement target liquid is supplied to the decarbonation device 56, pH adjustment may be performed if necessary. In a case where a degassing device is used as the decarbonation device 56, it is preferable to make the measurement target liquid acidic (the pH is 5 or lower, for example), because the carbonic acid removal rate will increase. The pH adjustment can be performed by adding a known acid, for example. Further, in a case where a reverse osmosis membrane (RO) or an ion exchange device is used for the filtration device described above, for example, if hydroxide ions are present in the measurement target liquid, the hydroxide ions can be removed, and thus, at least part of the pH adjustment can be performed by the filtration device.

[0032] In the TOC meter 54, the flow path of the measurement target liquid is split on the downstream side of the decarbonation device 56, and the oxidation device 58 and the CO_2 detection device 60 are provided in one flow path while the CO_2 detection device 62 is provided in the other flow path.

[0033] For example, the oxidation device 58 of the TOC meter 54 irradiates the measurement target liquid with ultraviolet rays, to oxidize organic substances contained in the measurement target liquid, including urea. Actually, most of the components other than urea among the organic substances contained in the measurement target liquid have been removed, and therefore, the organic substance to be oxidized by the oxidation device 58 is urea. That is, at the oxidation device 58, urea in the measurement target liquid is oxidatively decomposed, and carbon dioxide is newly generated at this stage.

[0034] The CO_2 detection devices 60 and 62 of the TOC meter 54 measure the amount of carbon dioxide in the treatment target liquid. The amount of carbon dioxide is proportional to the amount of carbon contained in the organic substance in the oxidatively decomposed measurement target liquid.

[0035] Here, on the upstream side of the CO_2 detection device 60, the organic substance in the measurement target liquid has been oxidized by the oxidation device 58, and the CO_2 detection device 60 detects the all carbon concentration in the measurement target liquid. On the other hand, on the upstream side of the CO_2 detection device 62, the organic substance in the measurement target liquid has not been oxidized by the oxidation device 58, and the CO_2 detection device 62 detects the inorganic carbon concentration in the measurement target liquid. In the TOC meter 54, as shown below in Expression (1), the all organic carbon concentration

concentration equal to or lower than an allowable value determined from the allowable urea concentration for the ultrapure water is merged with the raw water or the pretreated water at the upstream side of the primary treatment.

[0057] Here, in a case in which the urea concentration in the second raw water exceeds the allowable value determined from the allowable urea concentration for the ultrapure water, the second raw water may be introduced into the urea decomposition apparatus, to adjust the urea concentration to the allowable value or lower.

[0058] Further, the amount of the second raw water to be merged with the raw water or the pretreated water may be configured such that a weighted average of the urea concentration in the raw water or the pretreated water and the urea concentration in the second raw water becomes equal to or lower than the allowable urea concentration for the ultrapure water.

[0059] (Effects)

The present embodiment is configured as described above, and the effects thereof are described below. In the ultrapure water production system 100 according to the present embodiment, second raw water containing sewage treatment water, in addition to raw water using clean water, is used to produce ultrapure water. Accordingly, the proportion of the clean water in the raw water to be used in the ultrapure water production can be lowered.

[0060] Further, in a case in which the urea concentration in the second raw water exceeds the allowable value determined from the allowable urea concentration for ultrapure water, the urea decomposition unit 13 is used, and the second raw water is introduced into the urea decomposition apparatus 32, to adjust the urea concentration to the allowable value or lower. After that, the second raw water is merged with the raw water using clean water. Thus, sewage water can be more effectively utilized.

[0061] Further, the amount of the second raw water to be merged with the raw water is set depending on the allowable urea concentration for ultrapure water, and thus, the urea concentration in the ultrapure water can be restricted to be equal to or lower than the standard.

[0062] Furthermore, in a case in which the urea decomposition apparatus 32 is set before the raw water and the second raw water are mixed, it is possible to reduce size, compared with that in a case in which the urea decomposition apparatus 32 is set after the raw water and the second raw water are mixed. In particular, in a case in which the urea decomposition apparatus 32 is set closer to the primary treatment unit 11 or the pretreatment unit 10 than the merging point of the raw water and the second raw water, it is necessary to design the urea decomposition apparatus 32 so that the urea concentration in ultrapure water falls within the specification even if the urea concentration reaches the maximum value. As a result, the urea decomposition apparatus 32 becomes very large. Therefore, the installation area is large, and, at the same time,

CLAIMS

Claim 1. An ultrapure water production method, comprising:

a pretreatment of obtaining pretreated water by removing suspended substances from raw water containing clean water;

a primary treatment of producing primary pure water by removing all organic carbon components and ionic components from the pretreated water; and

a secondary treatment of producing ultrapure water by removing impurities from the primary pure water,

wherein second raw water that contains sewage treatment water is merged with the raw water or the pretreated water at an upstream side of the primary treatment.

Claim 2. The ultrapure water production method according to claim 1, wherein an amount of the second raw water to be merged with the raw water or the pretreated water is configured such that a weighted average of a urea concentration in the raw water or the pretreated water and a urea concentration in the second raw water becomes equal to or lower than an allowable value determined from an allowable urea concentration for the ultrapure water.

Claim 3. The ultrapure water production method according to claim 1 or 2, wherein, in a case in which a urea concentration in the second raw water exceeds an allowable value determined from an allowable urea concentration for the ultrapure water, the second raw water is introduced into a urea decomposition apparatus.

Claim 4. An ultrapure water production system, comprising:

a pretreatment unit that obtains pretreated water by removing suspended substances from raw water containing clean water;

a primary treatment unit that produces primary pure water by removing all organic carbon components and ionic components from the pretreated water;

a secondary treatment unit that produces ultrapure water by removing impurities from the primary pure water; and

a urea meter that measures a urea concentration in second raw water containing sewage treatment water,

wherein the second raw water is merged with the raw water or the pretreated water at an upstream side of the primary treatment unit.

Claim 5. The ultrapure water production system according to claim 4, further comprising a urea decomposition unit that includes a urea decomposition apparatus that decomposes urea in the second raw water, and that introduces the second raw water into the urea decomposition apparatus to lower the urea concentration in a case in which the urea concentration exceeds an allowable value determined from an allowable urea concentration for the ultrapure water.

Claim 6. The ultrapure water production system according to claim 4, wherein an amount of the second raw water to be merged with the raw water or the pretreated water is configured such that a weighted average of a urea concentration in the raw water or the pretreated water and the urea concentration in the second raw water becomes equal to or lower than an allowable value determined from an allowable urea concentration for the ultrapure water.