

STERILIZED WATER PRODUCTION APPARATUS

[FIELD OF THE INVENTION]

[0001]

The present invention relates to a sterilized water production apparatus for preparing strong sterilized water from water such as city water or well water.

[DESCRIPTION OF THE RELATED ART]

[0002]

Conventionally, sterilized water production apparatuses capable of producing sterilized water exhibiting strong sterilizing power in large quantity by mixing sodium hypochlorite and an acid such as hydrochloric acid or acetic acid to raw water such as city water or well water have developed. A sterilized water production apparatus of this type comprises a mixing device for mixing raw water with sodium hypochlorite and acid, in which sterilized water is produced by adding sodium hypochlorite measured for proper quantity and a properly measured acid independently to a predetermined quantity of raw water introduced into the mixing device to prepare two kinds of mixed waters, and then mixing the two kinds of mixed waters together (refer to, for example, Patent Document 1).

Patent Document 1: Japanese Patent Laid-Open No. 2001-300547
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[0003]

Such a conventional mixing device may cause a direct contact of sodium hypochlorite with acid at the time of mixing the sodium hypochlorite and acid into raw water, and if pH is reduced to below 4.5 by the direct

contact of sodium hypochlorite with acid, chlorine gas is generated. Since the conventional mixing device might cause partial generation of chlorine gas depending on the mixing state of sodium hypochlorite and acid, mechanisms for eliminating chlorine gas from the mixing device and treating the eliminated chlorine gas were needed.

[0004]

Therefore, a mixing device adapted to prevent generation of chlorine gas in mixing the sodium hypochlorite and acid into raw water was developed. The mixing device adapted to prevent the generation of chlorine gas is shown in Fig. 2. The mixing device (mixing means) 10 comprises a cubic housing 12, and a raw water passage 14, a first passage 16 and a second passage 18 branched from the raw water passage 14, and a junction passage 20 where the first passage 16 is combined with the second passage 18, the passages being formed within the housing 12. The housing 12 may be formed by connecting pipes corresponding to the respective passages instead of the cubic shape. A raw water inlet pipe 22 connecting with the raw water passage 14 is attached to the housing 12 to introduce raw water into the raw water passage 14 through the raw water inlet pipe 22, and the raw water is dividedly carried from the raw water passage 14 to the first passage 16 and the second passage 18. A mixing pipe 24 connecting with the junction passage 20 is attached to the housing 12 to discharge the water reaching the junction passage 20 to the outside via the mixing pipe 24.

[0005]

Sodium hypochlorite is introduced from a first electromagnetic pump 26 to the middle of the first passage 16 through a first connecting passage 28, a first check valve 30 and a first inlet tube 32. A tip opening part of the first inlet tube 32 is opened in substantially the sectional center position of

the first passage 16 so as to ensure the input of the sodium hypochlorite discharged from the first inlet tube 32 to the first passage 16 by the operation of the first electromagnetic pump 26. An acid such as hydrochloric acid or acetic acid is introduced from a second electromagnetic pump 34 to the middle of the second passage 18 through a second connecting passage 36, a second check valve 38 and a second inlet tube 40. A tip opening part of the second inlet tube 40 is opened in substantially the sectional center position of the second passage so as to ensure the input of the acid such as hydrochloric acid or acetic acid discharged from the second inlet tube 40 to the second passage 18 by the operation of the second electromagnetic pump 34.

[0006]

A mixer 42 is provided on the downstream side (the junction passage 20 side) from the opening position of the first inlet tube 32 within the first passage 16, and a mixer 44 is provided on the downstream side (the junction passage 20 side) from the opening position of the second inlet tube 40 within the second passage 18. Further, a mixer 46 is provided also within the mixing pipe 24. As the material of the mixers 42, 44 and 46 for mixing raw water with chemicals, those never corroded by acid are used. The mixers 42, 44 and 46 have, for example, the shape shown in Fig. 3, but the shape is not limited by the one shown in Fig. 3.

[0007]

In the thus-constituted mixing device 10, half the inlet quantity of the raw water introduced to the raw water passage 14 from the raw water inlet pipe 22 is introduced to the first passage 16, and the remainder of the inlet quantity is introduced to the second passage 18. In the first passage 16, sodium hypochlorite discharged from the first inlet tube 32 is added to

the raw water passing therethrough, and the sodium hypochlorite and the raw water are then mixed together by the mixer 42, whereby mixed water of raw water and sodium hypochlorite is prepared. In the second passage 18, the acid discharged from the second inlet tube 40 is added to the raw water passing therethrough, and the acid and the raw water are then mixed together by the mixer 44, whereby mixed water of raw water and acid is prepared. The mixed water of raw water and sodium hypochlorite is combined with the mixed water of raw water and acid in the junction passage 20, and the raw water, the sodium hypochlorite and the acid are mixed together by the mixer 46 within the mixing pipe 24, whereby sterilized water capable of sterilizing various bacteria is produced. The sterilized water is thereafter discharged out through the mixing pipe 24.

[0008]

In the mixing device 10 shown in Fig. 2, sodium hypochlorite that is a chemical solution never directly contacts with the acid such as hydrochloric acid or acetic acid that is a chemical solution. Namely, the sodium hypochlorite is diluted with raw water, the acid is also diluted with raw water, and the diluted sodium hypochlorite and the diluted acid are mixed together by the mixer 46 in the mixing pipe 24. Since both the sodium hypochlorite and the acid are diluted, and the mixing thereof is mutual mixing of dilution water, no chlorine gas is generated. By using the mixing device 10 shown in Fig. 2, the sodium hypochlorite and the acid can be mixed with raw water without generating chlorine gas to produce sterilized water.

[0009]

As the means for inputting the sodium hypochlorite and the acid to raw water, as shown in Fig. 2, the tip opening part of the first inlet tube 32

is opened to the passage sectional central position of the first passage 16, and the tip opening part of the second inlet tube 40 is opened to the passage sectional central position of the second passage 18. Other means for inputting the sodium hypochlorite and the acid are shown in Figs. 4 and 5. Figs. 4 and 5 show an example of inputting sodium hypochlorite to the first passage 16 from the first inlet tube 32. A connecting passage 50 connecting with the first passage 16 at a right angle is provided in the middle of the first passage 16. A valve 52 composed of a flexible material, which is generally called a duckbill valve, is attached to the tip of the opening part of the first inlet tube 32. This valve 52 has a cylindrical shape having an end surface 54, with a slit-like injection port 56 formed at the end surface 54. When the valve 52 is attached to the opening part of the inlet tube 32, a basin space 58 is formed within the valve 52 (in front of the opening part position of the first inlet tube 32).

[0010]

The end surface 54 of the valve 52 is disposed within the connecting passage 50 sufficiently deep from the connecting position with the first passage 16. The first electromagnetic pump 26 (second electromagnetic pump 34) is intermittently operated, and the injection port 56 of the valve 52 is closed during the time between operations of the first electromagnetic pump 26 so as not to inject the sodium hypochlorite from the valve 52. On the other hand, when the first electromagnetic pump 26 is operated, the sodium hypochlorite fed out of the first electromagnetic pump 26 pushes the sodium hypochlorite collected in the basin space 58 to open the injection port 56 of the valve 52, and the sodium hypochlorite is injected through the injection port 56. The sodium hypochlorite reaches the first passage 16 by the injecting force from the injection port 56, and mixes with raw water in

the first passage 16. Namely, in order to inject the sodium hypochlorite into the first passage 16 by the force of the first electromagnetic pump 26 and the valve 52, the injection port 56 of the valve 52 (the opening part of the first inlet tube 32) is disposed in a deep position of the connecting passage 50.

[DISCLOSURE OF THE INVENTION]

[Problems to be Solved by the Invention]

[0011]

The operation intervals of the first electromagnetic pump 26 and the second electromagnetic pump 34 are often extremely extended depending on the degree of dilution of the respective mixed waters. The operation interval of the first electromagnetic pump 26 is set longer in case of reducing the chlorine concentration, and the operation interval of the second electromagnetic pump 26 is set longer in case of raising the pH value. When the flow rate of raw water is reduced, the operation interval of the first electromagnetic pump 26 and the operation intervals of the second electromagnetic pump 34 are extended also in proportion to the flow rate. The first electromagnetic pump 26 will be then described as an example. A long operation interval of the first electromagnetic pump 26 causes the state where the sodium hypochlorite is not mixed with the raw water passing through the first passage 16 during the long interval from the first discharge of sodium hypochlorite to the second discharge of sodium hypochlorite, and mixed water close to raw water reaches the junction passage 20. Similarly, a long operation interval of the second electromagnetic pump 34 causes the state where the acid is not mixed with the raw water passing through the second passage 18, and mixed water

close to raw water reaches the junction passage 20. As the result, the mixed water (sterilized water) to be discharged from the mixing pipe 24 includes intermittently formed mixed water with different pH value and intermittently formed mixed water with intermittently different available free hypochlorous acid concentration, caused by the mixing of sodium hypochlorite and acid, and sterilized water with constant pH value or constant available free hypochlorous acid concentration cannot be produced.

[0012]

Even if the tip opening part of the first inlet tube 32 or the second inlet tube 40 is opened in the sectional central position of the first passage 16 or the second passage 18 as shown in Fig. 2, or even if the valve 52 shown in Fig. 4 is attached to the tip of the first inlet tube 32 (the second inlet tube 40), and the position of the valve 52 is set in a deep position of the connecting passage 50 distant from the first passage 16 (the second passage 18), the pH value or available free hypochlorous acid concentration of the produced sterilized water cannot be made constant in case of a long operation interval of the first electromagnetic pump 26 or the second electromagnetic pump 34.

[0013]

From the above-mentioned points, the present invention has an object to provide a sterilized water production apparatus capable of regularly keeping the pH value or available free hypochlorite acid concentration of the produced sterilized water constant even in case that the operation interval of an electromagnetic pump is long.

[Means for Solving the Problems]

[0014]

To attain the above-mentioned object, the present invention involves

a sterilized water production apparatus for forming sterilized water by discharging sodium hypochlorite from a first electromagnetic pump toward a first passage through a first inlet tube to prepare mixed water of raw water and sodium hypochlorite in the first passage, discharging an acid from a second electromagnetic pump toward a second passage through a second inlet tube to prepare mixed water of raw water and acid in the second passage, and mixing the mixed water of raw water and sodium hypochlorite with the mixed water of raw water and acid, the apparatus comprising a connecting passage connecting with the first passage, and an opening part of the first inlet tube being arranged within the connecting passage so as to generate a vortex by the raw water and the sodium hypochlorite in a connecting position with the first passage of the connecting passage and protrude a part of the generated vortex toward the first passage side. In this sterilized water production apparatus, the relation of $1/3D \leq B \leq 2.5D$ is satisfied when the distance from the opening part of said first inlet tube to the connecting position with said first passage in said connecting passage is B and the maximum passage sectional position of the connecting passage is D, and the relation of $1/8P' \leq P < P'$ is satisfied when the pressure of the raw water passing through said first passage is P and the pressure of the sodium hypochlorite discharged into said connecting passage through the opening part of said first inlet tube is P'.

[0015]

The present invention further involves a sterilized water production apparatus for generating sterilized water by discharging sodium hypochlorite from a first electromagnetic pump toward a first passage through a first inlet tube to prepare mixed water of raw water and sodium hypochlorite in the first passage, discharging an acid from a second

electromagnetic pump toward a second passage through a second inlet tube to prepare mixed water of raw water and acid in the second passage, and mixing the mixed water of raw water and sodium hypochlorite with the mixed water of raw water and acid, said apparatus including a connecting passage connecting with said second passage, and an opening part of said second inlet tube being arranged within said connecting passage so as to generate a vortex by the raw water and the acid in a connecting position with said second passage of said connecting passage, and protrude a part of the generated vortex toward said second passage side. In this sterilized water production apparatus, further, the relation of $1/3D \leq B \leq 2.5D$ is satisfied when the distance from the opening part of said second inlet tube to the connecting position with said second passage in said connecting passage is B and the maximum passage sectional of said connecting passage is D, and the relation of $1/8P' \leq P < P'$ is satisfied when the pressure of the raw water passing through said second passage is P and the pressure of the acid discharged into said connecting passage through the opening part of said second inlet tube is P'.

[Effect of the Invention]

[0016]

According to the mixing means of the present invention, in case that the interval from the discharge of sodium hypochlorite or acid by the first operation of the electromagnetic pump to the second discharge is long, uniform amounts of sodium hypochlorite and acid can be regularly mixed into the passage for passing raw water. According to this, mixed water of sodium hypochlorite mixed into raw water in a constant concentration and mixed water of acid mixed into raw water in a constant concentration can be obtained. Therefore, even if the operation interval of the electromagnetic

pump is long, sterilized water with constant pH value or constant available free hypochlorous acid concentration can be regularly produced.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0017]

Fig. 1 is a sectional view showing one embodiment of an essential part of a sterilized water production apparatus according to the present invention;

Fig. 2 is a sectional perspective view of a conventional mixing device used for a sterilized water production apparatus;

Fig. 3 is a perspective view of a mixer used in Figs. 1 and 2;

Fig. 4 is an essential sectional view of the apparatus in which a valve is attached to an opening part of an inlet tube; and

Fig. 5 is a perspective view of the valve.

[Description of Numeral Reference]

[0018]

- 10: Mixing device
- 12: Housing
- 16: First passage
- 18: Second passage
- 26: First electromagnetic pump
- 32: First inlet tube
- 34: Second electromagnetic pump
- 40: Second inlet tube
- 50: Connecting passage
- 60: Vortex

[BEST MODE FOR CARRYING OUT THE INVENTION]

[0019]

The present invention will be further described in reference to the drawings. Fig. 1 is a sectional view showing an embodiment of an essential part of a sterilized water production apparatus according to the present invention. In Fig. 1, the same reference number as the reference number shown in Figs. 2 and 4 shows the same member. Fig. 1 shows an example of inputting sodium hypochlorite to the first passage 16 from the first inlet tube 32. In the present invention, the valve 52 shown in Figs. 4 and 5 is not used, and the opening part of the first inlet tube 32 is disposed within the communicating passage 50. When the housing 12 is formed of pipes, the connecting passage 50 has a circular section having a diameter of D . The connecting passage 50 is desirably set to a circular section having the same diameter D as the first passage 16, but is not limited thereby. Generally, a pipe with an inside diameter D of about $10\text{ mm} \leq D \leq 36\text{ mm}$, particularly, a pipe with $D = \text{about } 22\text{ mm}$ is used for the sterilized water production apparatus. However, the dimension of the inside diameter D is not limited thereby. Both the connecting passage 50 and the first passage 16 may have rectangular sections, and in this case, the larger side is taken as D . The distance between the connecting position with the first passage 16 in the connecting passage 50 and the position of the tip opening part of the first inlet tube 32 is taken as B . In the present invention, the opening part of the first inlet tube 32 is disposed within the connecting passage 50 so as to satisfy the relation of $1/3D \leq B \leq 2.5D$.

[0020]

In the present invention, further, when the pressure of the raw

water passing through the first passage 16 at the connecting position with the connecting passage 50 is P , and the pressure of the sodium hypochlorite discharged into the connecting passage 50 through the opening part of the first inlet tube 32 is P' , both the pressures are set to satisfy the relation of $1/8P' \leq P < P'$.

[0021]

The opening part of the first inlet tube 32 is disposed within the connecting passage 50 so as to satisfy $1/3D \leq B \leq 2.5D$, and P and P' are set to satisfy $1/8P' \leq P < P'$, whereby the sodium hypochlorite discharged from the first inlet tube 32 into the connecting passage 50 generates a vortex 60 mixed with raw water in the vicinity of the connecting position with the first passage 16 of the connecting passage 50. This vortex 60 is formed by a part of the raw water passing through the first passage 16 and flowing into the connecting passage 50 and the sodium hypochlorite discharged into the connecting passage 50 from the first inlet tube 32 but not directly reaching the first passage 16. The shape of the vortex 60 takes an elliptic shape or a shape different therefrom depending on the length of B . By setting the distance B within the range of $1/3D \leq B \leq 2.5D$, a part of the vortex 60 (half or less the size of the vortex 60) composed of sodium hypochlorite and raw water is protruded into the first passage 16. The sodium hypochlorite discharged from the first inlet tube 32 is prevented from directly reaching the first passage 16 by setting the range of $1/8P' \leq P < P'$.

[0022]

By protruding a part of the vortex 60 containing sodium hypochlorite into the first passage 16, the sodium hypochlorite discharged into the connecting passage 50 from the first inlet tube 32 by the operation of the first electromagnetic pump 26 (refer to Fig. 2) is partially mixed with the

raw water passing through the first passage 16, but mostly left in the connecting passage 50 as the vortex 60. Thereafter, the sodium hypochlorite contained in the vortex 60 is carried over the vortex 60 and successively mixed with the raw water passing through the first passage 16. At that time, almost all of the first sodium hypochlorite discharged into the connecting passage 50 from the first inlet tube 32 by the first electromagnetic pump 26 is mixed with the raw water passing through the first passage 16 until the second sodium hypochlorite is discharged from the first inlet tube 32. According to this, mixed water with a regularly constant mixing ratio of sodium hypochlorite to raw water can be prepared in the first passage 16.

[0023]

The length of the distance B is adjusted according to the operation interval of the first electromagnetic pump 26, whereby the sodium hypochlorite discharged first can be entirely inputted to and mixed with the raw water carried in the first passage 16 before the second sodium hypochlorite is discharged. As described above, when $1.3D \leq B \leq 2.5D$ is satisfied, part of the vortex 60 containing sodium hypochlorite is protruded into the first passage 16. When B is smaller than $1/2D$, most of the vortex 60 of sodium hypochlorite is protruded into the first passage 16, and all the sodium hypochlorite discharged first is mixed with the raw water carried in the first passage 16 before the second discharge of sodium hypochlorite is performed after the first discharge of sodium hypochlorite, causing the state where only the raw water is carried in the first passage 16. On the other hand, when B is larger than $2.5D$, the first sodium hypochlorite discharged from the first inlet tube 32 never reaches the first passage 16, and the first sodium hypochlorite cannot be entirely mixed with the raw water carried in

the first passage 16.. Thus, a failure that uniform mixed water of raw water and sodium hypochlorite cannot be prepared in the first passage 16 occurs.

[0024]

When P is smaller than $1/8P'$, the sodium hypochlorite discharged from the first inlet tube 32 reaches the first passage 16, and when P is larger than P' , the discharge quantity of sodium hypochlorite cannot be ensured. Therefore, the range of P is set to $1/8P' \leq P < P'$.

[0025]

Although the structure for mixing the sodium hypochlorite discharged from the first electromagnetic pump 26 into the raw water carried in the first passage 16 was illustrated in Fig. 1, the same can be said for the structure for mixing the acid discharged from the second electromagnetic pump 34 (refer to Fig. 2) into the raw water carried in the second passage 18 ($1/3D \leq B \leq 2.5D$ and $1/8P' \leq P < P'$). In the sterilized water production apparatus, it is often performed to reduce the available free chlorine concentration by extending only the operation interval of the first electromagnetic pump 26, or reduce the pH value by extending only the operation interval of the second electromagnetic pump 34. Therefore, this structure may be applied only to a position for discharging sodium hypochlorite by the first electromagnetic pump 26 and the first inlet tube 32, or applied only to a position for discharging the acid by the second electromagnetic pump 34 and the second inlet tube 40, or applied to both the positions.

CLAIMS

1. A sterilized water production apparatus for forming sterilized water by discharging sodium hypochlorite from a first electromagnetic pump toward a first passage through a first inlet tube to prepare mixed water of raw water and sodium hypochlorite in the first passage, discharging an acid from a second electromagnetic pump toward a second passage through a second inlet tube to prepare mixed water of raw water and acid in the second passage, and mixing the mixed water of raw water and sodium hypochlorite with the mixed water of raw water and acid,

said apparatus comprising a connecting passage connecting with said first passage, and an opening part of said first inlet tube being arranged within said connecting passage so as to generate a vortex by the raw water and the sodium hypochlorite in a connecting position with said first passage of said connecting passage and protrude a part of the generated vortex toward said first passage side.

2. The sterilized water production apparatus according to claim 1, wherein the relation of $1/3D \leq B \leq 2.5D$ is satisfied when the distance from the opening part of said first inlet tube to the connecting position with said first passage in said connecting passage is B and the maximum passage sectional position of said connecting passage is D, and the relation of $1/8P' \leq P < P'$ is satisfied when the pressure of the raw water passing through said first passage is P and the pressure of the sodium hypochlorite discharged into said connecting passage through the opening part of said first inlet tube is P'.

3. A sterilized water production apparatus for forming sterilized water by discharging sodium hypochlorite from a first electromagnetic pump toward a first passage through a first inlet tube to prepare mixed water of

raw water and sodium hypochlorite in the first passage, discharging an acid from a second electromagnetic pump toward a second passage through a second inlet tube to prepare mixed water of raw water and acid in the second passage, and mixing the mixed water of raw water and sodium hypochlorite with the mixed water of raw water and acid,

said apparatus including a connecting passage connecting with said second passage, and an opening part of said second inlet tube being arranged within said connecting passage so as to generate a vortex by the raw water and the acid in a connecting position with said second passage of said connecting passage, and protrude a part of the generated vortex toward said second passage side.

4. The sterilized water production apparatus according to claim 3, wherein the relation of $1/3D \leq B \leq 2.5D$ is satisfied when the distance from the opening part of said second inlet tube to the connecting position with said second passage in said connecting passage is B and the maximum passage sectional part of said connecting passage is D, and the relation of $1/8P' \leq P < P'$ is satisfied when the pressure of the raw water passing through said second passage is P and the pressure of the acid discharged into said connecting passage through the opening part of said second inlet tube is P'.