

DESCRIPTION

Title of Invention

METHOD AND DEVICE FOR TREATING WASTEWATER CONTAINING ORGANIC MATTER

Technical Field

[0001]

The present invention relates to a method and a device for treating wastewater containing organic matter, which are capable of efficiently decomposing and removing organic matter in wastewater containing organic matter with ozone. The present invention particularly relates to a method and a device for treating wastewater containing organic matter, which are suitable for a case where carbonate ions and bicarbonate ions (hereinafter sometimes referred to as inorganic carbonate) are contained in water to be treated.

Background Art

[0002]

As a method for removing organic matter in wastewater containing organic matter, a method of oxidizing and decomposing organic matter with ozone for removal is hitherto known. It is also known that at the time of decomposing organic matter with ozone as thus described, pH is simultaneously adjusted by addition of

hydrogen peroxide (H_2O_2), filling with a catalyst, irradiation with ultraviolet rays (UV), or addition of alkali, so as to improve the oxidation action of the ozone and accelerate the decomposition.

[0003]

In the oxidation of the organic matter with the ozone in the wastewater, hydroxyl radical ($\bullet\text{OH}$) is generated and this radical acts on the organic-matter decomposition. When carbonate ions and bicarbonate ions are present in water to be treated, these consume hydroxyl radical to inhibit the organic-matter decomposition.

[0004]

Patent Literature 1 discloses that, in advance of ozone treatment, water to be treated is adjusted to pH6 or lower to bring carbonate ions and bicarbonate ions in the water into carbon dioxide for degassing, thereby efficiently removing a carbonic acid component in a carbon dioxide form and another dissolved gas from the water to be treated.

[0005]

Patent Literature 1 discloses using ozone treatment and hydrogen peroxide (H_2O_2) treatment in combination. Adding hydrogen peroxide to the water to be treated in advance of adding ozone thereto improves the power of oxidation by ozone.

[0006]

Patent Literature 1 discloses that adding alkali such as sodium hydroxide to the water to be treated in advance of adding the ozone, and setting pH to neutral to 11, preferably 9 to 11, enables acceleration of the oxidation reaction.

[0007]

Patent Literature 2 discloses a device including: piping at least a part of which is a longitudinal pipe section extending vertically; a water-passing means that feeds wastewater containing organic matter to the piping such that the wastewater containing organic matter flows downward in the longitudinal pipe section; an ejector provided in an upper part of the longitudinal pipe section; a gas feeding means that feeds oxidizable gas to the ejector; and a static mixer provided downstream of the ejector in the piping. By blowing the oxidizable gas from the ejector into the longitudinal pipe section in this manner, the efficiency in contact between the oxidizable gas and the solution is enhanced, and the organic matter is efficiently subjected to oxidation decomposition treatment.

Citation List

Patent Literature

[0008]

PTL 1: JP 2001-113291 A

PTL 2: JP 2013-208554 A

Summary of Invention

[0009]

An object of the present invention is to provide a method and a device for treating wastewater containing organic matter which are capable of efficiently decomposing and removing, with ozone, organic matter in wastewater containing organic matter and inorganic carbonate.

[0010]

A treatment method for wastewater containing organic matter according to the present invention is a treatment method for wastewater containing organic matter, using a treatment device for wastewater containing organic matter, the device including: piping at least a part of which is a longitudinal pipe section extending vertically; a water-passing means that feeds wastewater containing organic matter to the piping such that the wastewater containing organic matter flows downward in the longitudinal pipe section; an ejector provided in an upper part of the longitudinal pipe section; an ozone feeding means that feeds ozone-containing gas to the ejector; and a static mixer provided downstream of the ejector in the piping, and in the treatment method, a ratio A/B between an ozone concentration A (g/Nm^3) in the ozone-containing gas and an inorganic carbonate

concentration B (g/L) in water that flows into the ejector is set to 500 to 1000.

[0011]

A treatment device for wastewater containing organic matter according to the present invention is a treatment device for wastewater containing organic matter, the device including: piping at least a part of which is a longitudinal pipe section extending vertically; a water-passing means that feeds wastewater containing organic matter to the piping such that the wastewater containing organic matter flows downward in the longitudinal pipe section; an ejector provided in an upper part of the longitudinal pipe section; an ozone feeding means that feeds ozone-containing gas to the ejector; and a static mixer provided downstream of the ejector in the piping, and in the treatment device, a means is provided which sets a ratio A/B between an ozone concentration A (g/Nm^3) in the ozone-containing gas and an inorganic carbonate concentration B (g/L) in water that flows into the ejector to 500 to 1000.

[0012]

In one aspect of the present invention, the wastewater containing organic matter, which is fed to the ejector, is subjected to the inorganic carbonate removal treatment in the inorganic carbonate removal means.

[0013]

In one aspect of the present invention, the static mixer is installed perpendicularly, and the water flowing out of the ejector passes downward through the static mixer.

Advantageous Effect of Invention

[0014]

In the method and device for treating wastewater containing organic matter according to the present invention, by setting the ratio A/B to 500 to 1000, the organic-matter decomposition efficiency is improved and a total organic carbon (TOC) concentration in treated water is made low.

Brief Description of Drawings

[0015]

[Fig. 1] Fig. 1 is an explanatory diagram showing an example.

[Fig. 2] Fig. 2 is an explanatory diagram showing another example.

Description of Embodiment

[0016]

Hereinafter, an embodiment will be described with reference to the drawings. Fig. 1 is a flow block diagram of a treatment device for wastewater containing organic matter according to the embodiment.

[0017]

After acid is added to water to be treated by an acid addition means 2 in a pipe 1, the water to be treated is introduced into an inorganic carbonate removal device 3, and inorganic carbonate is removed. The acid added by the acid addition means 2 is suitably sulfuric acid, and is preferably added such that pH of the water to be treated after the addition becomes 5 to 6. By adding the acid to make the pH of the water to be treated acidic in this manner, the inorganic carbonate becomes carbon dioxide, thereby improving the efficiency in removal of the inorganic carbonate in the subsequent inorganic carbonate removal device 3.

[0018]

The present invention is characterized in that a ratio between an inorganic carbonate concentration and an ozone concentration is set to be constant, and hence there are no limits on an inorganic carbonate concentration in the water to be treated. By the above treatment, the inorganic carbonate concentration in the water is reduced normally to 1.0 g/L or lower, and particularly to about 0.01 to 0.5 g/L. Examples of the inorganic carbonate removal device 3 may include a decarboxylation tower, a decarboxylation film, a film degasifier, a vacuum degasifier, and a nitrogen degasifier, and a decarboxylation tower is particularly

suitable, but the inorganic carbonate removal device 3 is not limited thereto.

[0019]

The water, from which the inorganic carbonate has been removed in the inorganic carbonate removal device 3, is boosted in a pump 4, hydrogen peroxide is added to the water by a hydrogen peroxide addition means 6, alkali is added to the water by an alkali addition means 7, the water is fed to an ejector 8 via a pipe 5, and ozone is added.

[0020]

From the hydrogen peroxide addition means 6, the hydrogen peroxide is added such that a ratio E/C between an ozone feed amount E (g/H) per unit time in the ejector 8 and an amount C(g/H) of hydrogen peroxide added per unit time from the hydrogen peroxide addition means 6 is preferably from 1 to 10, and particularly preferably from 2 to 6. The hydrogen peroxide acts as a radical reaction initiator and accelerates the decomposition reaction of organic matter by the ozone.

[0021]

From the alkali addition means 7, a NaOH aqueous solution is preferably added, and is added such that the pH of the water becomes 7 to 11, particularly 8 to 10. As thus described, making the pH of the water alkaline accelerates the oxidation reaction of organic matter by the ozone.

[0022]

A gas inlet in a throat section of the ejector 8 is connected to an ozone generator 10 via a pipe 9 and is configured such that an ozone-containing gas is sucked into the ejector 8. As the ozone generator 10, those capable of adjusting an ozone concentration in an ozone-containing gas to be generated, such as an electrolytic type and a discharge type, are preferred.

[0023]

The ejector 8 is installed such that a water jetting direction is vertically downward, and the pipe 5 is connected to a working fluid inlet at the upper end of the ejector 8. An outlet of the ejector 8 is connected to an inlet at the upper end of a static mixer 12 via a perpendicular pipe 11.

[0024]

The static mixer 12 is configured by accommodating a flow path material for stirring in a tubular casing, and in the present embodiment, the static mixer 12 is installed such that the tubular casing is provided perpendicularly. By perpendicularly installing the static mixer 12 and allowing the water to flow downward in this manner, ozone-containing bubbles move upward by a buoyant force in the static mixer 12, so that the time during which the ozone stays in the static mixer 12 becomes long to improve the ozone dissolution efficiency.

[0025]

The water flowing out of an outflow section at the lower end of the static mixer 12 is introduced into a treated water tank 14 via a pipe 13 and treated water is taken out of the treated water tank 14.

[0026]

In the present invention, the inorganic carbonate concentration in the water that is fed to the ejector 8 may be detected with an inorganic carbonate sensor (not shown). Alternatively, a flow rate of the water to be treated flowing in the pipe 1 or the pipe 5 may be measured with a flowmeter (not shown).

[0027]

An amount of the ozone fed from the ozone generator 10 to the ejector 8 is controlled by controlling an electric current in the ozone generator 10 or controlling an opening of a valve (not shown) provided in the pipe 9.

[0028]

In the present invention, a ratio A/B between an ozone concentration A (g/Nm^3) in the ozone-containing gas that is fed to the ejector 8 and an inorganic carbonate concentration B (g/L) in the water that is fed from the pipe 5 to the ejector 8 is set to 500 to 1000. For setting: $A/B = 500$ to 1000, at least either an amount of inorganic carbonate removed in the inorganic carbonate removal device 3 or the ozone concentration in the ozone-containing gas that is fed to the ejector 8 is controlled.

[0029]

When A/B is lower than 500, ozone dissolved in the water is consumed by the inorganic carbonate to cause deterioration in organic-matter decomposition efficiency. On the other hand, when A/B is equal to or higher than 1000, an extremely high ozone concentration causes ozone to react with and consume each other, conversely leading to deterioration in organic-matter decomposition efficiency. By setting A/B to 500 to 1000, consumption of ozone by the inorganic carbonate and reaction and consumption between ozone gases can be held to the minimum, to improve the organic-matter decomposition efficiency.

[0030]

The hydrogen peroxide addition means 6 is installed in the above description, but instead of the hydrogen peroxide addition means 6, there may be installed a means of adding a halogenic agent such as sodium hypochlorite, chlorine dioxide, or sodium hypobromite. An amount of the halogenic agent added in this case is preferably such an amount that a ratio E/D between an amount E (g/h) of ozone added to the ejector 8 per unit time and an amount D (g/h) of the halogenic medical agent injected per unit time becomes 1 to 6, particularly 2 to 5.

Examples

[0031]

[Example 1]

Using a device with a configuration just as in Fig. 1 except that the acid addition means 2, the inorganic carbonate removal device 3, and the alkali addition means 7 were not installed (cf. Fig. 2), water to be treated with a TOC of 20 mg/L, an inorganic carbonate concentration of 200 mg/L ($B = 0.2 \text{ g/L}$), and a pH of 8.5 was treated. A flow rate of the water to be treated was assumed to be $50 \text{ m}^3/\text{h}$. The ozone concentration A in the ozone-containing gas, fed to the ejector 8, was set to 100 g/Nm^3 and the feed amount (flow rate) of the ozone-containing gas was set to $30 \text{ Nm}^3/\text{h}$.

[0032]

As the ejector 8, a water jet mixer manufactured by NORITAKE CO., LIMITED was used.

[0033]

Table 1 shows a TOC removal ratio and main conditions among those described above.

[0034]

[Examples 2, 3, Comparative Examples 1 to 3]

The above water to be treated was treated on the same conditions as in Example 1 except that the ozone concentration A in the ozone-containing gas, fed to the ejector 8, was set as in Table 1. Table 1 shows the results.

[0035]

[Table 1]

	Example 1	Example 2	Example 3	Comparative Example 1	Comparative Example 2	Comparative Example 3
Ozone Concentration A (g/Nm ³)	100	150	200	50	75	250
Inorganic Carbonate Concentration B (g/L)	0.2	0.2	0.2	0.2	0.2	0.2
A/B	500	750	1000	250	375	1250
TOC Removal Ratio (%)	80	82	83	54	68	75

[0036]

[Example 4]

Using a device having the acid addition means 2, the inorganic carbonate removal device 3, and the alkali addition means 7 installed just as in Fig. 1, the same water to be treated as described above was treated.

[0037]

As the inorganic carbonate removal device 3, a decarboxylation tower was installed. Sulfuric acid was added from the acid addition means 2 so as to set pH to 6. A sodium hydroxide aqueous solution was added from the alkali addition means 7 so as to set pH to 8.5. By the inorganic carbonate removal treatment, the inorganic carbonate concentration in the water (water flowing into the ejector 8) became 100 mg/L.

[0038]

Other conditions were made the same as in Example 1. Table 2 shows the results.

[0039]

[Examples 5, 6, Comparative Examples 4 to 6]

The above water to be treated was treated on the same conditions as in Example 4 except that the ozone concentration A in the ozone-containing gas, fed to the ejector 8, was set as in Table 2. Table 2 shows the results.

[0040]

[Table 2]

	Example 4	Comparative Example 4	Comparative Example 5	Example 5	Example 6	Comparative Example 6
Ozone Concentration A (g/Nm ³)	100	150	200	50	75	250
Inorganic Carbonate Concentration B (g/L)	0.1	0.1	0.1	0.1	0.1	0.1
A/B	1000	1500	2000	500	750	2500
TOC Removal Ratio (%)	82	72	70	79	80	68

[0041]

As apparent from Tables 1 and 2, it was found that according to each example with the setting of the concentration ratio A/B between ozone and inorganic carbonate to 500 to 1000, the TOC removal ratio is extremely high as compared to the comparative examples.

[0042]

Although the present invention has been described in detail using the specific aspects, it is obvious to a person skilled in the art that various changes can be

made without deviating from the intention and scope of the present invention.

The present application is based on Japanese Patent Application No. 2016-096244 filed with the Japan Patent Office on May 12, 2016, the entire contents of which are incorporated herein by reference.

Reference Signs List

[0043]

- 2 acid addition means
- 3 inorganic carbonate removal device
- 8 ejector
- 9 ozone generator
- 12 static mixer
- 14 treated water tank

CLAIMS

[Claim 1]

A treatment method for wastewater containing organic matter, using a treatment device for wastewater containing organic matter, the device comprising:

piping at least a part of which is a longitudinal pipe section extending vertically;

a water-passing means that feeds wastewater containing organic matter to the piping such that the wastewater containing organic matter flows downward in the longitudinal pipe section;

an ejector provided in an upper part of the longitudinal pipe section;

an ozone feeding means that feeds ozone-containing gas to the ejector; and

a static mixer provided downstream of the ejector in the piping,

wherein a ratio A/B between an ozone concentration A (g/Nm³) in the ozone-containing gas and an inorganic carbonate concentration B (g/L) in water that flows into the ejector is set to 500 to 1000.

[Claim 2]

The treatment method for wastewater containing organic matter according to claim 1, wherein the wastewater containing organic matter, which is fed to the

ejector, is subjected to the inorganic carbonate removal treatment in the inorganic carbonate removal means.

[Claim 3]

The treatment method for wastewater containing organic matter according to claim 1 or 2, wherein the static mixer is installed perpendicularly, and the water flowing out of the ejector passes downward through the static mixer.

[Claim 4]

A treatment device for wastewater containing organic matter, the device comprising:

piping at least a part of which is a longitudinal pipe section extending vertically;

a water-passing means that feeds wastewater containing organic matter to the piping such that the wastewater containing organic matter flows downward in the longitudinal pipe section;

an ejector provided in an upper part of the longitudinal pipe section;

an ozone feeding means that feeds ozone-containing gas to the ejector; and

a static mixer provided downstream of the ejector in the piping,

wherein a means is provided which sets a ratio A/B between an ozone concentration A (g/Nm^3) in the ozone-containing gas and an inorganic carbonate concentration B (g/L) in water that flows into the ejector to 500 to 1000.