

DESCRIPTION

ELECTROLYSIS SYSTEM

5 TECHNICAL FIELD

[0001]

The present invention relates to an electrolysis system including an electrolysis apparatus that generates electrolyzed water which is obtained by performing electrolysis of seawater or saltwater and contains hypochlorous acid.

10 The present application claims priority based on Japanese Patent Application No. 2014-228012 filed on November 10, 2014, the contents of which are incorporated herein by reference.

BACKGROUND ART

15 [0002]

In the related art, in a thermal power generation plant, a nuclear power generation plant, or the like which uses a large amount of seawater, there is a problem that algae or shellfish is adhered to and breeds on a part thereof in contact with seawater, such as an intake or a pipe thereof, a steam condenser, and various coolers.

20 In order to solve the problem, a marine organism adhesion preventing device in which electrolysis is performed on natural seawater so as to generate sodium hypochlorite (chlorine, sodium hypochlorite), and electrolyzed water containing sodium hypochlorite is injected to an intake, and thus adhering of a marine organism is prevented is proposed (for example, see Patent Document 1).

25 [0003]

A deoxygenation method of injecting ammonia having a large value of pH (hydrogen ion exponent) (for example, pH 7 to pH 10.5) is known for removing oxygen which is the cause of corrosion of a water supply system in the plant. However, it is assumed that ammonia concentration in a drain from the plant will be increased henceforth by using ammonia as an oxygen scavenger. On the other hand, reduction of nitrogen is also required by drainage regulations, and a quick response is desired.

Patent Document 2 discloses an ammonia nitrogen removal device that decomposes ammonia by chlorine treatment with sodium hypochlorite which is obtained by performing electrolysis of seawater.

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RELATED ART DOCUMENT

PATENT DOCUMENT

[0004]

Patent Document 1: Japanese Unexamined Patent Application, First Publication
No. H10-85750

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Patent Document 2: Japanese Unexamined Patent Application, First Publication
No. 2014-563

SUMMARY

20 PROBLEMS TO BE SOLVED BY THE INVENTION

[0005]

In the plant such as a thermal power generation plant, in which a large amount of seawater is taken, and waste water such as boiler waste water, which contains ammonia nitrogen is discharged, it is necessary that a marine organism adhesion preventing device and an ammonia nitrogen removal device are separately installed.

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[0006]

That is, in the marine organism adhesion preventing device, a method for controlling in which concentration of hypochlorous acid contained in electrolyzed water is changed while setting the flow rate of the injected electrolyzed water to be constant, and for controlling the flow rate of the injected electrolyzed water and the concentration of the hypochlorous acid is provided. On the other hand, in the ammonia nitrogen removal device, the concentration of hypochlorous acid is set to be constant and the injected amount of electrolyzed water is changed so as to perform an operation control.

Thus, it is difficult to perform both types of treatments of marine organism adhesion prevention and ammonia nitrogen removal, only by using one seawater electrolysis apparatus.

[0007]

The present invention is to provide an electrolysis system in which it is possible to suppress adhering of a marine organism at an intake and to remove a nitrogen component included in a nitrogen-containing waste water which is discharged from the plant, by using one electrolysis apparatus.

MEANS FOR SOLVING THE PROBLEM

[0008]

According to a first aspect of the present invention, an electrolysis system includes a seawater line in which seawater introduced into a plant flows, a nitrogen treatment tank into which nitrogen-containing waste water discharged from the plant is introduced, an electrolysis apparatus that performs electrolysis of seawater or saltwater so as to generate electrolyzed water which contains hypochlorous acid, an injection line through which the electrolyzed water is injected into the seawater line, and a branch line

which is branched from the injection line and is used for injecting the electrolyzed water into the nitrogen treatment tank.

[0009]

According to such a configuration, it is possible to suppress adhering of a
5 marine organism at a seawater line and to remove a nitrogen component included in nitrogen-containing waste water which is discharged from a plant, by using one electrolysis apparatus.

[0010]

The electrolysis system may further include a control device that adjusts a flow
10 rate of the electrolyzed water which is introduced through the branch line, based on the amount of hypochlorous acid of the electrolyzed water which is generated by the electrolysis apparatus.

[0011]

According to such a configuration, it is possible to maintain the amount of
15 hypochlorous acid supplied to the nitrogen treatment tank and the amount of hypochlorous acid injected to the seawater line to be constant.

[0012]

The electrolysis system may further include a circulation flow passage in which the seawater is circulated. In the electrolysis system, the electrolysis apparatus may be
20 disposed to perform electrolysis of the seawater in the middle of the circulation flow passage, and the control device may control the nitrogen-containing waste water to stay in the nitrogen treatment tank for a period when the amount of hypochlorous acid in the electrolyzed water which flows out from the circulation flow passage reaches a predetermined amount.

25 [0013]

According to such a configuration, it is possible to prevent nitrogen-containing waste water which is not sufficiently subjected to nitrogen treatment from being discharged to the outside of the system.

5 ADVANTAGE OF THE INVENTION

[0014]

According to the present invention, it is possible to suppress adhering of a marine organism at an intake and to remove a nitrogen component included in nitrogen-containing waste water which is discharged from a plant, by using one
10 electrolysis apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

FIG. 1 is a schematic configuration diagram illustrating an electrolysis system
15 according to a first embodiment of the present invention.

FIG. 2 is a schematic configuration diagram illustrating an electrolysis system according to a second embodiment of the present invention.

FIG. 3 is a schematic configuration diagram illustrating an electrolysis system according to a modification example of the second embodiment of the present invention.
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DESCRIPTION OF THE EMBODIMENTS

[0016]

(First embodiment)

An electrolysis system 1 according to a first embodiment of the present
25 invention will be described in detail with reference to the drawings.

FIG. 1 is a schematic configuration diagram illustrating the electrolysis system 1 according to the first embodiment of the present invention. As illustrated in FIG. 1, the electrolysis system 1 is a system which includes a combined cycle power plant P, a seawater electrolysis apparatus 2, a control device (not illustrated), as the main components. The combined cycle power plant P includes a waste heat recovery boiler B.

The combined cycle power plant P (referred to as a plant P below) includes a gas turbine (not illustrated), a waste heat recovery boiler B (referred to as a boiler B below) to which an exhaust gas from the gas turbine is delivered, a steam turbine (not illustrated), and a power generator (not illustrated) that is driven by a rotational driving force of the gas turbine and the steam turbine, so as to generate power.

[0017]

Seawater M which has been taken from an intake 4 of the seawater line 3 is introduced into the plant P. The seawater M is discharged after being used, for example, for cooling. For example, boiler water of the boiler B contains ammonia as an oxygen scavenger for removing oxygen which is the cause of corrosion. Thus, boiler waste water W discharged from the boiler B is ammonia nitrogen-containing waste water which contains ammonia nitrogen such as ammonia (NH_3) and an ammonium ion (NH_4^+). The boiler waste water W is stored in a drain tank 6, and then is introduced into a nitrogen treatment tank 7. The boiler waste water W was discharged through a waste water line 22 after nitrogen is removed in the nitrogen treatment tank 7.

[0018]

The electrolysis system 1 includes a seawater supply pump 8 and the seawater electrolysis apparatus 2 that performs electrolysis of seawater M introduced by the seawater supply pump 8. The seawater supply pump 8 may have a configuration for

directly drawing the seawater M from the sea, or have a configuration for drawing seawater M from the seawater line 3.

The seawater supply pump 8 and the seawater electrolysis apparatus 2 are connected to each other by a seawater supply line 12. A first flow rate sensor 13 that
5 measures a flow rate of the seawater M and a first flow rate control valve 14 that controls the flow rate of the seawater M are provided in the seawater supply line 12. A strainer for preventing mixing of a foreign substance functioning as an obstacle of electrolysis may be provided in the seawater supply line 12.

[0019]

10 The seawater electrolysis apparatus 2 includes an electrolytic cell 9 and a DC power supply device 10. The seawater electrolysis apparatus 2 is an apparatus that performs electrolysis of the seawater M so as to generate electrolyzed water E which contains sodium hypochlorite (chlorine, sodium hypochlorite). The electrolytic cell 9 includes a plurality of electrodes (not illustrated).

15 The DC power supply device 10 is a device that supplies a current used for electrolysis of the seawater M. For example, the DC power supply device 10 may have a configuration of including a DC power source and a constant current control circuit. The DC power source is a power source configured to output DC power. For example, the DC power source may have a configuration of rectifying AC power which has been
20 output from an AC power source into DC power and outputting the DC power.

The seawater electrolysis apparatus 2 in the embodiment is a one-through type in which seawater M is caused to pass in the electrolytic cell 9 once.

[0020]

The electrolyzed water E generated by the seawater electrolysis apparatus 2 is
25 injected into the intake 4 of the seawater line 3 through an injection line 15. The

electrolyzed water E (sodium hypochlorite) is injected into the intake 4, and thus it is possible to suppress adhering of a marine organism to the intake 4. That is, the seawater electrolysis apparatus 2 according to the embodiment has a function as a marine organism adhesion preventing device.

5 A hypochlorous acid concentration sensor 19 configured to measure hypochlorous acid concentration of electrolyzed water E flowing in the injection line 15 is provided in the injection line 15.

[0021]

A branch line 16 is branched from the injection line 15 for connecting the
10 seawater electrolysis apparatus 2 and the intake 4. The electrolyzed water E is introduced into the nitrogen treatment tank 7 through the branch line 16. That is, the electrolyzed water E generated by the seawater electrolysis apparatus 2 is introduced into the nitrogen treatment tank 7 through the branch line 16 branched from the injection line 15, and then is mixed with boiler waste water W.

15 A second flow rate sensor 17 configured to measure the flow rate of the electrolyzed water E and a second flow rate control valve 18 configured to control the flow rate of the electrolyzed water E are provided in the branch line 16.

[0022]

A pH measurement device 20 and a pH adjusting device 21 are provided in the
20 nitrogen treatment tank 7. The pH measurement device 20 measures pH (hydrogen ion exponent) of treatment water configured by the boiler waste water W and the electrolyzed water E in the nitrogen treatment tank 7. The pH adjusting device 21 adjusts pH of the treatment water in the nitrogen treatment tank 7.

The boiler waste water W and the electrolyzed water E are introduced into the
25 nitrogen treatment tank 7, and a solution reaction of ammonia provided in the boiler

waste water W with hypochlorous acid is caused to perform decomposition to a nitrogen gas (N_2). That is, the seawater electrolysis apparatus 2 according to the embodiment has a function as an ammonia nitrogen removal device.

[0023]

5 A control method of the electrolysis system 1 in the embodiment will be described.

 The control device controls the DC power supply device 10 in the seawater electrolysis apparatus 2 based on the amount of hypochlorous acid required in the intake 4 (referred to as a first hypochlorous acid content below). The control device calculates
10 the first hypochlorous acid content by using the flow rate of the seawater M measured by the first flow rate sensor 13 and using the hypochlorous acid concentration measured by the hypochlorous acid concentration sensor 19. The control device controls the DC power supply device 10 based on the calculated first hypochlorous acid content, and thus adjusts the hypochlorous acid concentration of the generated electrolyzed water E.

15 [0024]

 Here, the amount of hypochlorous acid required in the intake 4 is the minimum amount required for causing hypochlorous acid to be almost consumed in the intake 4, and causing the hypochlorous acid to be hardly discharged. The first hypochlorous acid content is calculated by a predetermined method at a predetermined time interval. The
20 first hypochlorous acid content is not constant, but continuously changed.

 The control device adjusts the hypochlorous acid concentration of the electrolyzed water E in accordance with the first hypochlorous acid content.

[0025]

 On the other hand, the control device calculates the amount of hypochlorous
25 acid per unit time, which is required in the nitrogen treatment tank 7 (referred to as a

second hypochlorous acid content below). The second hypochlorous acid content is substantially constant.

The control device adjusts the flow rate (referred to as a second flow rate below) of electrolyzed water E2 introduced into the nitrogen treatment tank 7 through the branch line 16, based on the calculated second hypochlorous acid content and the hypochlorous acid concentration which has been measured by the hypochlorous acid concentration sensor 19. The second flow rate may be calculated based on the second hypochlorous acid content and the hypochlorous acid concentration.

Specifically, the control device controls the second flow rate sensor 17 to measure the flow rate of the branch line 16, and performs a control of adjusting the second flow rate control valve 18, so as to cause the measured flow rate to satisfy the second flow rate.

[0026]

The control device performs a control of controlling the flow rate of the seawater M introduced through the seawater supply line 12 in order to perform compensation of the flow rate (referred to as the first flow rate below) of electrolyzed water E1 flowing in the injection line 15. The first flow rate is reduced in accordance with the second flow rate. That is, if the flow rate of the seawater M is set as F_M , the flow rate of the electrolyzed water E flowing in the injection line 15 is set as F_1 , the flow rate of the electrolyzed water E flowing in the branch line 16 is set as F_2 , the flow rate of the introduced seawater M is increased so as to satisfy $F_M = F_1 + F_2$.

Specifically, the control device controls the first flow rate sensor 13 to measure the flow rate of the seawater supply line 12, and performs a control of adjusting the first flow rate control valve 14, so as to cause the measured flow rate to satisfy the calculated flow rate of the seawater M.

[0027]

In the nitrogen treatment tank 7, a pH regulator is added so as to perform adjustment of pH, by using the pH adjusting device 21 based on pH which has been measured by the pH measurement device 20, such that pH of the treatment water in the nitrogen treatment tank 7 becomes predetermined pH.

[0028]

According to the embodiment, it is possible to suppress adhering of a marine organism at the intake 4 and to remove a nitrogen component included in nitrogen-containing waste water which is discharged from the plant P, by using one seawater electrolysis apparatus 2.

[0029]

In addition, the flow rate of the electrolyzed water E2 introduced through the branch line 16 is adjusted based on the amount of hypochlorous acid in the electrolyzed water E which is generated by the seawater electrolysis apparatus 2, and thus it is possible to maintain the amount of hypochlorous acid supplied to the nitrogen treatment tank 7 and the amount of hypochlorous acid injected to the seawater line 3 to be constant.

[0030]

(Second embodiment)

An electrolysis system 1B according to a second embodiment of the present invention will be described with reference to the drawings. In this embodiment, descriptions will be made focusing on differences from the above-described first embodiment. Descriptions of similar parts will be not repeated.

A seawater electrolysis apparatus 2 in the electrolysis system 1B according to this embodiment includes a circulation flow passage 24 for circulating electrolyzed water E (seawater M). The seawater electrolysis apparatus 2 is disposed to perform

electrolysis of the seawater M in the middle of the circulation flow passage 24. That is, the seawater electrolysis apparatus 2 in this embodiment employs a recycling method in which seawater M is circulated in the circulation flow passage 24, and thus hypochlorous acid concentration of the electrolyzed water E is gradually increased.

5 [0031]

A return line 27 is branched from a waste water line 22 in the electrolysis system 1B according to this embodiment. The return line 27 is used for bringing waste water which flows in the waste water line 22 back to a drain tank 6.

[0032]

10 A control method of the electrolysis system 1B in this embodiment will be described.

If seawater M is introduced into the circulation flow passage 24, the seawater M gradually performs electrolysis treatment while circulating the circulation flow passage 24, until a period when the seawater M becomes electrolyzed water E having
15 predetermined hypochlorous acid concentration. That is, when the seawater electrolysis apparatus 2 is set up, or after settings of the electrolysis system 1B are changed, a predetermined period until the seawater M has hypochlorous acid concentration determined based on a first hypochlorous acid content is required.

[0033]

20 The control device operates valves 28 which are respectively provided in the waste water line 22 and the return line, so as to perform a control of bringing waste water which is discharged from the nitrogen treatment tank 7 back to the drain tank 6 through the return line 27. The control is performed for a period until the amount of hypochlorous acid in the electrolyzed water E which flows out from the circulation flow
25 passage 24 reaches a predetermined amount. That is, a control of causing waste water

which is not sufficiently subjected to nitrogen treatment to stay in the nitrogen treatment tank 7 is performed.

A control similar to the control of the electrolysis system 1 in the first embodiment is performed at a stage in which the amount of hypochlorous acid in the electrolyzed water E reaches the predetermined amount.

[0034]

A method of causing the waste water to stay in the nitrogen treatment tank 7 is not limited thereto. For example, the size of the nitrogen treatment tank 7 may be sufficiently increased without providing the return line 27. In this configuration, the valve 29 on the waste water line 22 is set to be in a closed state, and thus the waste water can be caused to stay in the nitrogen treatment tank 7.

[0035]

According to the embodiment, when the seawater electrolysis apparatus 2 is set up, or after settings of the electrolysis system 1B are changed, the waste water is caused to stay in the nitrogen treatment tank 7. Thus, it is possible to prevent nitrogen-containing waste water which is not sufficiently subjected to nitrogen treatment, from being discharged to the outside of the system.

In other words, according to the embodiment, it is possible to perform both types of treatments of marine organism adhesion prevention and ammonia nitrogen removal in the recycling type which has a high effect of preventing an occurrence of scale in the electrolytic cell 9, in addition to in the one-through type seawater electrolysis apparatus 2 in which seawater M is caused to pass in the electrolytic cell 9 once as described in the first embodiment.

[0036]

(Modification example of second embodiment)

An electrolysis system 1C of a modification example of the second embodiment will be described.

As illustrated in FIG. 3, a third flow rate sensor 25 and a third flow rate control valve 26 are provided in an injection line 15 in this modification example. The third
5 flow rate sensor 25 measures the flow rate of electrolyzed water E which flows in the injection line 15. The third flow rate control valve 26 controls the flow rate of the electrolyzed water E1. That is, the electrolysis system 1 in this modification example is a system in which the concentration of the electrolyzed water E1 which flows in the injection line 15, and the flow rate of the electrolyzed water E1 can be controlled.

10 [0037]

Similar to the control device in the second embodiment, a control device in this modification example operates valves 28 and 29 which are respectively provided on the waste water line 22 and the return line 27, so as to perform a control of bringing waste water which is discharged from the nitrogen treatment tank 7 back to the drain tank 6
15 through the return line 27. The control is performed for a period until the amount of hypochlorous acid in the electrolyzed water E which flows out from the circulation flow passage 24 reaches a predetermined amount.

[0038]

According to the modification example, even in a case where the flow rate of the
20 injection line 15 and the concentration of the electrolyzed water E are changed, it is possible to perform both types of the treatments of marine organism adhesion prevention and ammonia nitrogen removal.

[0039]

Hitherto, the embodiments of the present invention are described with reference
25 to the drawings. However, the configurations in the embodiment and combinations

thereof are just one example. Addition, omission, substitution, and other changes of the components may be made in a range without departing from the gist of the present invention. The present invention is not limited to the embodiments, and is limited only by the scope of the claims.

5 For example, in each of the embodiments, the configuration in which the seawater M is introduced into the seawater electrolysis apparatus 2 is described. However, a configuration in which saltwater is introduced into the seawater electrolysis apparatus 2 may be made. That is, a liquid introduced into the seawater electrolysis apparatus 2 may contain chlorine ions (Cl^-) similar to the seawater M.

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BRIEF DESCRIPTION OF THE REFERENCE SYMBOLS

[0040]

1, 1B, 1C: electrolysis system

2: seawater electrolysis apparatus (electrolysis apparatus)

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3: seawater line

4: intake

6: drain tank

7: nitrogen treatment tank

8: seawater supply pump

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9: electrolytic cell

10: dc power supply device

12: seawater supply line

13: first flow rate sensor

14: first flow rate control valve

25

15: injection line

- 16: branch line
- 17: second flow rate sensor
- 18: second flow rate control valve
- 19: hypochlorous acid concentration sensor
- 5 20: ph measurement device
- 21: ph adjusting device
- 22: waste water line
- 24: circulation flow passage
- 25: third flow rate sensor
- 10 26: third flow rate control valve
- 27: return line
- B: boiler
- E, E1, E2: electrolyzed water
- M: seawater
- 15 P: plant
- W: boiler waste water (nitrogen-containing waste water)

CLAIMS

1. An electrolysis system comprising:

a seawater line drawing seawater from the sea and introducing the seawater into

5 a plant;

a nitrogen treatment tank into which nitrogen-containing waste water discharged from the plant is introduced;

an electrolysis apparatus that generates electrolyzed water which contains hypochlorous acid so as to electrolyze the seawater, wherein the seawater is introduced

10 from the seawater line or is draw from the sea;

an injection line through which the electrolyzed water is injected into the seawater line;

a branch line which is branched from the injection line and is used for injecting the electrolyzed water into the nitrogen treatment tank;

15 a control device that adjusts a flow rate of the electrolyzed water which is introduced into the nitrogen treatment tank through the branch line, based on the amount of hypochlorous acid of the electrolyzed water which is generated by the electrolysis apparatus;

a circulation flow passage which is branched on the upstream side of a branch
20 portion of the injection line, which introduces the electrolyzed water discharged from the downstream side of the electrolysis apparatus to the upstream side of the electrolysis apparatus, wherein the electrolyzed water is circulated in the circulation flow passage;

a waste water line which is removed waste water discharged from the nitrogen treatment tank; and

25 a return line which is used for bringing the waste water which flows in the waste

water line back to a line between the plant and the nitrogen treatment tank;

wherein the control device controls the nitrogen-containing waste water to stay in the nitrogen treatment tank for a period when the amount of hypochlorous acid in the electrolyzed water of the injection line reaches a predetermined amount.