

DESCRIPTION

Title of Invention

AMMONIA PROCESSING SYSTEM

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Technical Field

[0001]

The present invention relates to an ammonia processing system, particularly to an ammonia processing system in which ammonia included in a boiler waste water which is water discharged from a boiler facility is processed.

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Priority is claimed on Japanese Patent Application No. 2014-238637, filed on November 26, 2014, the content of which is incorporated herein by reference.

Background Art

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[0002]

For example, in a thermal power generation plant, hydrazine is used for removing oxygen which is the cause of corrosion. The hydrazine is considered as “a chemical substance of which mutagenicity is admitted”. Thus, recently, employing the hydrazine as a safer oxygen scavenger or employing the hydrazine in water treatment in which the oxygen scavenger is not used proceeds.

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Ammonia which having a large value of hydrogen ion exponent (pH) (for example, pH 7 to pH 10.5) is known as an oxygen scavenger which does not use hydrazine. However, it is assumed that ammonia concentration in a drain from the plant is increased henceforth by using ammonia as an oxygen scavenger (for example, see NPL 1). Reduction of nitrogen is also required by drainage regulations, and a quick response

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is desired.

[0003]

PTL 1 discloses an ammonia processing system in which ammonia is decomposed by chlorine treatment with sodium hypochlorite which is obtained by performing electrolysis of seawater. In the ammonia processing system, boiler waste water which is ammonia-containing waste water is introduced into a mixing tank, and hypochlorous acid is added to the mixing tank. Thus, a solution reaction of ammonia provided in the boiler waste water with hypochlorous acid is caused to perform decomposition to a nitrogen gas.

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Citation List

Patent Literature

[0004]

PTL 1: Japanese Unexamined Patent Application, First Publication No.

15 2014-563

Non-Patent Literature

[0005]

NPL 1: “Aspects on Non-Toxic Oxygen Scavenger in Power Plant Cycle Chemistry”, [online], Mitsubishi Heavy Industries technical review, Vol.46 No.2 (2009)

20 [searched on March 30, 2012], Internet <URL:

<http://www.mhi.co.jp/technology/review/pdf/462/462055.pdf>>

Summary of Invention

Technical Problem

25 [0006]

In the system disclosed in PTL 1, the capacity of the mixing tank is determined in accordance with a reaction time of boiler waste water and hypochlorous acid.

However, if the reaction time of the boiler waste water and the hypochlorous acid becomes longer, an increase of the capacity of the mixing tank is required.

5 [0007]

An object of the invention is to provide an ammonia processing system which can reduce the reaction time of the boiler waste water and the hypochlorous acid.

Solution to Problem

10 [0008]

According to a first aspect of the present invention, there is provided an ammonia processing system which includes a drainage line through which boiler waste water is supplied to a mixing tank, a pH measurement device which is provided on the drainage line and is configured to measure pH of the boiler waste water which flows in
15 the drainage line, a pH adjustment device that adds a pH regulator for adjusting the pH of the boiler waste water to the boiler waste water, an electrolysis device that performs electrolysis of seawater or saltwater so as to generate electrolyzed water which contains hypochlorous acid, a supply line which is provided on an upstream of a confluent portion of the drainage line and the mixing tank and is configured to supply hypochlorous acid
20 generated by the electrolysis device to the boiler waste water, and a control device that controls the amount of the added pH regulator based on a measurement value of the pH measurement device.

[0009]

According to such a configuration, the pH regulator is added to adjust the pH of
25 the boiler waste water, and thus it is possible to reduce a reaction time of the boiler waste

water and hypochlorous acid.

[0010]

In the ammonia processing system, the pH measurement device may be provided at a position at which pH of the boiler waste water, which is adjusted by the pH regulator added by the pH adjustment device is stable, on a downstream side of the pH adjustment device.

[0011]

According to such a configuration, it is possible to measure the pH of the boiler waste water by the pH measurement device with more accuracy. Thus, it is possible to accurately adjust the pH of the boiler waste water by the pH adjustment device.

[0012]

The ammonia processing system may further include a storage tank which is provided on an upstream side of the drainage line and is configured to store the boiler waste water, and a storage tank pH measurement device that measures the pH of the boiler waste water stored in the storage tank. In the ammonia processing system, the control device may control the amount of hypochlorous acid generated by the electrolysis device, based on a measurement value of the storage tank pH measurement device.

Advantageous Effects of Invention

[0013]

According to the present invention, the pH regulator is added to adjust the pH of the boiler waste water, and thus it is possible to reduce a reaction time of the boiler waste water and hypochlorous acid.

Brief Description of Drawings

[0014]

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

FIG. 2 is a graph illustrating a relationship between an ammonia decomposition
5 rate and pH of boiler waste water in a mixing tank of the ammonia processing system according to the embodiment of the present invention.

FIG. 3 is a schematic configuration diagram illustrating an ammonia processing system according to a second embodiment of the present invention.

10 Description of Embodiments

[0015]

(First embodiment)

Hereinafter, an ammonia processing system 1 according to a first embodiment of the present invention will be described in detail with reference to the drawings.

15 FIG. 1 is a schematic configuration diagram illustrating a plant P which includes the ammonia processing system 1 according to the first embodiment of the present invention. As illustrated in FIG. 1, the ammonia processing system 1 is a system for processing boiler waste water W which is discharged from a combined cycle power plant P including a waste heat recovery boiler B.

20 [0016]

The ammonia processing system 1 includes a seawater electrolysis device 2 and a control device 8, as the main components.

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)
25 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 3 of seawater through a first
5 seawater supply line 4 is introduced into the plant P. The seawater M is used, for example, for cooling. A seawater supply pump (not illustrated) for delivering seawater M, and a seawater flow rate control valve (not illustrated) that controls a flow rate of seawater M are provided in the first seawater supply line 4.

For example, in boiler water of the boiler B, ammonia is used as an oxygen
10 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^+).

[0018]

The boiler waste water W discharged from the boiler B is stored in a storage
15 tank 5. A dilution water introduction device 6 for inserting reducing-temperature dilution water (industrial water) which is used for reducing the temperature of boiler waste water W into the storage tank 5 is provided in the storage tank 5. The temperature of treatment water in the storage tank 5 is managed to be equal to or lower than a predetermined temperature, based on a temperature which has been measured by a
20 thermometer (not illustrated) which can measure the temperature of the treatment water. A storage tank pH measurement device 7 that measures pH (hydrogen ion exponent) of the treatment water in the storage tank 5 is provided in the storage tank 5.

[0019]

A mixing tank 9 is provided on a downstream side of the storage tank 5. The
25 storage tank 5 and the mixing tank 9 are connected to each other through a drainage line

10. The boiler waste water W which is stored in the storage tank 5 and has a reduced temperature is introduced into the mixing tank 9 through the drainage line 10. The boiler waste water W is introduced into the mixing tank 9, and then is discharged. A waste water supply pump 16 that delivers the boiler waste water W stored in the storage tank 5 to the mixing tank 9 is provided in the drainage line 10.

[0020]

The seawater electrolysis device 2 is a device that performs electrolysis of seawater M introduced from the intake 3 through a second seawater supply line 11. A seawater supply pump 14 for delivering seawater M and a seawater flow rate control valve 15 that controls a flow rate of seawater M are provided in the second seawater supply line 11.

The seawater electrolysis device 2 includes an electrolytic cell 12 and a DC power supply device 13. The seawater electrolysis device 2 is a device that performs electrolysis of the seawater M so as to generate electrolyzed water E which contains sodium hypochlorite (chlorine, sodium hypochlorite). The electrolytic cell 12 includes a plurality of electrodes (not illustrated).

[0021]

The DC power supply device 13 is a device that supplies a current used for electrolysis of the seawater M. For example, the DC power supply device 13 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 output from an AC power source into DC power and outputting the DC power.

[0022]

25 The seawater electrolysis device 2 in the embodiment is a one-through method

in which seawater M is caused to pass in the electrolytic cell 12 once. The seawater electrolysis device 2 may employ a recycling method of circulating seawater in addition to the one-through method. In the recycling method, a downstream side of the electrolytic cell 12 (outlet of electrolytic cell 12) and an upstream side of the electrolytic cell 12 (inlet of electrolytic cell 12) are connected to each other by a circulation flow passage, and thus seawater is circulated. The seawater electrolysis device 2 may have any method as long as the seawater electrolysis device 2 can generate hypochlorous acid by using seawater M.

[0023]

Electrolyzed water E which has been generated by the seawater electrolysis device 2 is introduced into the mixing tank 9 through the supply line 18, and is mixed with boiler waste water W.

A line mixer 21 configured to accelerate mixing of the boiler waste water W and the electrolyzed water E is provided on a downstream side (mixing tank 9 side) of the confluent portion 20 with the supply line 18, on the drainage line 10.

[0024]

The boiler waste water W and the electrolyzed water E are introduced into the mixing tank 9, and a solution reaction of ammonia in the boiler waste water W with hypochlorous acid is caused to perform decomposition to a nitrogen gas (N_2). That is, ammonia is processed and the boiler waste water W is in a state of being allowed to be discharged, in the mixing tank 9.

[0025]

A pH adjustment device 23 and a pH measurement device 24 are provided on the drainage line 10 in the embodiment, in order from an upstream side. The pH adjustment device 23 adjusts pH (hydrogen ion exponent) of boiler waste water W

flowing in the drainage line 10. The pH measurement device 24 measures the pH of the boiler waste water W. The pH adjustment device 23 and the pH measurement device 24 are provided on an upstream side of the confluent portion 20 of the drainage line 10 and the supply line 18. That is, the pH measurement device 24 is provided on a downstream
5 side of the pH adjustment device 23, and electrolyzed water E is mixed on a downstream side of the pH measurement device 24.

[0026]

The pH adjustment device 23 is a device that adds a pH regulator to the boiler waste water W flowing in the drainage line 10, so as to adjust pH of the boiler waste
10 water W. As the pH regulator, acid such as hydrochloric acid or an alkaline agent is used. The boiler waste water W in this embodiment is alkaline in many cases. Thus, hydrochloric acid is mainly added.

[0027]

The pH measurement device 24 is installed on a clearly downstream side of the
15 pH adjustment device 23. Specifically, the pH measurement device 24 is disposed at a position capable of measuring the pH of boiler waste water W after adequately reacting by mixing the pH regulator added by the pH adjustment device 23. In other words, the pH measurement device 24 is disposed at a position at which pH of boiler waste water W, which is adjusted by the pH regulator added by the pH adjustment device 23 is stable.

[0028]

Here, a relationship between an ammonia decomposition rate and pH of boiler waste water W in the mixing tank 9 will be described. According to the examinations of the inventors, the relationship between the ammonia decomposition rate and pH of the boiler waste water W in the mixing tank 9 is as illustrated in FIG. 2. As illustrated in
25 FIG. 2, it is understood that a decomposition rate of ammonia in the mixing tank 9 is

increased in a case where the pH of the boiler waste water W is set to be about 8.5.

The control device 8 controls the pH adjustment device 23 to adjust the amount of the added pH regulator, based on the relationship, such that a measurement value of the pH measurement device 24 (that is, pH of the boiler waste water W on an upstream
5 side of the confluent portion 20 in the drainage line 10) satisfies $\text{pH}=7.5$ to 9.5 . For example, in a case where the pH of the boiler waste water W is 10 (alkaline side), the control device 8 controls the pH adjustment device 23 to add hydrochloric acid to the boiler waste water W.

[0029]

10 Next, an action of the ammonia processing system 1 according to the embodiment will be described.

Firstly, boiler waste water W discharged from the boiler B is stored in the storage tank 5. The pH of the boiler waste water W in the embodiment is about 10.5 and this value thereof indicates that the boiler waste water W is alkaline.

15 Simultaneously with the boiler waste water W, reducing-temperature dilution water is put into the storage tank 5. Thus, the pH of the boiler waste water W in the storage tank 5 becomes 9.9, for example. The boiler waste water W which has been stored in the storage tank 5 is delivered to the drainage line 10 at a predetermined rate, by using the waste water supply pump 16.

20 [0030]

The control device 8 puts the pH regulator into the boiler waste water W by using the pH adjustment device 23, based on pH which has been measured by the pH measurement device 24. The control device 8 controls the pH adjustment device 23 to cause pH of the boiler waste water W to satisfy 7.5 to 9.5.

25 [0031]

The control device 8 calculates the necessary amount of hypochlorous acid based on the pH of the boiler waste water W, which has been measured by the storage tank pH measurement device 7, and determines an output current value of the DC power supply device 13. The amount of the necessary electrolyzed water E is determined
5 based on a treatment time and the like in the mixing tank 9.

[0032]

The pH of the boiler waste water W measured by the storage tank pH measurement device 7 has a relationship with ammonia nitrogen concentration. Thus, the pH of the boiler waste water W is measured, and thus nitrogen concentration in
10 the storage tank 5 is obtained. The amount of hypochlorous acid has a relationship with the ammonia nitrogen concentration. The amount of hypochlorous acid is increased or decreased in proportion to a current value of the DC power supply device 13. Thus, pH of the boiler waste water W in the storage tank 5 is measured, and thus the DC power supply device 13 can be controlled and the amount of generated hypochlorous acid
15 (amount of removed ammonia nitrogen) can be determined.

[0033]

According to the embodiment, electrolyzed water E which contains hypochlorous acid is added to boiler waste water W which is waste water containing ammonia nitrogen, and thus it is possible to perform decomposition treatment of
20 ammonia contained in the boiler waste water W.

[0034]

The pH regulator is added so as to adjust pH of the boiler waste water W, and thus it is possible to reduce reaction time of the boiler waste water W and hypochlorous acid. In particular, pH is adjusted to be in a range of 7.5 to 9.5, and thus it is possible to
25 more reduce the reaction time of the boiler waste water W and hypochlorous acid.

[0035]

The pH regulator added to the boiler waste water W is disposed and added on the upstream side of the confluent portion 20 at which the electrolyzed water E is supplied. Thus, it is possible to adjust pH of the boiler waste water W without an influence of a pH change by the electrolyzed water E.

pH of the boiler waste water W in the storage tank 5 is measured, and thus the DC power supply device 13 can be controlled and the amount of generated hypochlorous acid can be determined.

[0036]

10 (Second embodiment)

An ammonia processing system 1B according to a second embodiment of the present invention will be described below 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.

15 [0037]

As illustrated in FIG. 3, the ammonia processing system 1B according to the embodiment includes an injection line 17 through which electrolyzed water E generated by the seawater electrolysis device 2 is injected to the intake 3. The electrolyzed water E (sodium hypochlorite) is injected to the intake 3, and thus it is possible to suppress adhering of a marine organism to the intake 3. That is, the seawater electrolysis device 2 in this embodiment has a function as a marine organism adhesion preventing device.

[0038]

The supply line 18 for supplying electrolyzed water E to the mixing tank 9 is branched from the injection line 17 for connecting the seawater electrolysis device 2 and the intake 3. That is, the electrolyzed water E generated by the seawater electrolysis

device 2 is introduced into the mixing tank 9 through the supply line 18 which is branched from the injection line 17. The introduced electrolyzed water E is mixed with boiler waste water W. A flow rate control valve 19 configured to control a flow rate of electrolyzed water E is provided in the supply line 18.

5 [0039]

The control device 8 controls the flow rate control valve 19, and thus controls the amount of electrolyzed water E (sodium hypochlorite) injected from the injection line 17. Similar to the control device 8 in the first embodiment, the control device 8 calculates the necessary amount of hypochlorous acid based on the pH of boiler waste
10 water W, which is measured by the storage tank pH measurement device 7, and determines an output current value of the DC power supply device 13. The amount of the necessary electrolyzed water E is determined based on a treatment time and the like in the mixing tank 9.

[0040]

15 The electrolyzed water E generated by the seawater electrolysis device 2 is injected to the intake 3 of the seawater M through the injection line 17. The electrolyzed water E is injected to the intake 3, and thus it is possible to suppress adhering of a marine organism to the intake 3.

[0041]

20 The technical range of the present invention is not limited to the above-described embodiments, and various changes can be added in a range without departing from the gist of the present invention.

For example, the supply line 18 for the electrolyzed water E in the embodiment is connected to the drainage line 10 in which the boiler waste water W flows. However,
25 the supply line 18 may be directly connected to the mixing tank 9.

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

Means for measuring the pH, residual chlorine, water quality, and the like may be provided in the mixing tank 9 or on a downstream of the mixing tank 9. A line for bringing waste water back to the storage tank 5 in a case where the waste water does not satisfy the standard may be provided.

Industrial Applicability

[0042]

According to the ammonia processing system, the pH regulator is added to adjust pH of the boiler waste water, and thus it is possible to reduce a reaction time of the boiler waste water and hypochlorous acid.

Reference Signs List

[0043]

1, 1B AMMONIA PROCESSING SYSTEM

2 SEAWATER ELECTROLYSIS DEVICE (ELECTROLYSIS DEVICE)

3 INTAKE

4 FIRST SEAWATER SUPPLY LINE

5 STORAGE TANK

6 DILUTION WATER INTRODUCTION DEVICE

7 STORAGE TANK pH MEASUREMENT DEVICE

	8	CONTROL DEVICE
	9	MIXING TANK
	10	DRAINAGE LINE
	11	SECOND SEAWATER SUPPLY LINE
5	12	ELECTROLYTIC CELL
	13	DC POWER SUPPLY DEVICE
	14	SEAWATER SUPPLY PUMP
	15	SEAWATER FLOW RATE CONTROL VALVE
	16	WASTE WATER SUPPLY PUMP
10	17	INJECTION LINE
	18	SUPPLY LINE
	19	FLOW RATE CONTROL VALVE
	20	CONFLUENT PORTION
	21	LINE MIXER
15	23	pH ADJUSTMENT DEVICE
	24	pH MEASUREMENT DEVICE
	B	BOILER
	E	ELECTROLYZED WATER
	M	SEAWATER
20	P	PLANT
	W	BOILER WASTE WATER

CLAIMS

1. An ammonia processing system comprising:

a drainage line through which boiler waste water is supplied to a mixing tank;

5 a pH measurement device that measures pH of the boiler waste water which flows in the drainage line;

a pH adjustment device which is provided on the drainage line and is configured to add a pH regulator for adjusting the pH of the boiler waste water to the boiler waste water;

10 an electrolysis device that performs electrolysis of seawater or saltwater so as to generate electrolyzed water which contains hypochlorous acid;

a supply line which is provided on an upstream of a confluent portion of the drainage line and the mixing tank and is configured to supply hypochlorous acid generated by the electrolysis device to the boiler waste water; and

15 a control device that controls the amount of the added pH regulator based on a measurement value of the pH measurement device.

2. The ammonia processing system according to Claim 1,

20 wherein the pH measurement device is disposed at a position at which pH of the boiler waste water, which is adjusted by the pH regulator added by the pH adjustment device is stable, on a downstream side of the pH adjustment device.

3. The ammonia processing system according to Claim 1 or 2, further comprising:

25 a storage tank which is provided on an upstream side of the drainage line and is

configured to store the boiler waste water; and

a storage tank pH measurement device that measures pH of the boiler waste water stored in the storage tank,

wherein the control device controls the amount of hypochlorous acid generated
5 by the electrolysis device, based on a measurement value of the storage tank pH measurement device.