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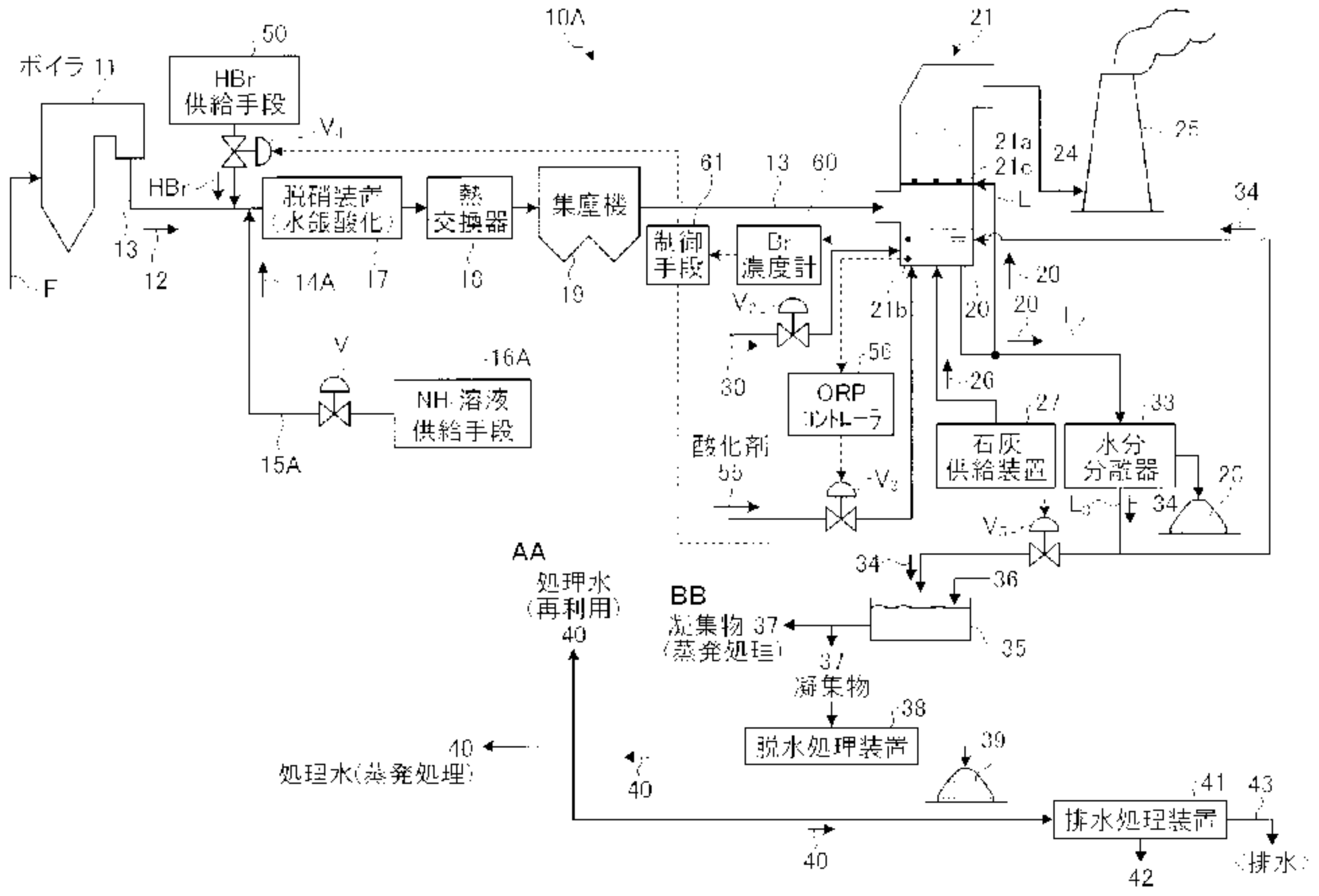
(54) **Titre :** SYSTEME DE TRAITEMENT DU MERCURE CONTENU DANS UN GAZ D'ECHAPPEMENT
(54) **Title:** TREATMENT SYSTEM FOR MERCURY IN FLUE GAS

[図1]



11	Boiler
16A	NH_3 solution supply means
17	Denitration device (mercury oxide)
18	Heat exchanger
19	Dust collector
27	Lime supply device
33	Moisture separator
37	Agglomerate
38	Dehydration treatment device
40	Treated water (evaporation treatment)
41	Waste water treatment device
43	Waste water
50	HBr supply means
55	Oxidizing agent
56	ORP controller
60	Br concentration meter
61	Control means
AA	Treated water (re-used)
BB	Agglomerate (evaporation treatment)

(57) **Abrégé/Abstract:**

Provided is a system for removing mercury in exhaust gas, where the system removes Hg contained in an exhaust gas from a boiler and comprises the following: a heat exchanger (AH) (18) which subjects an exhaust gas (12) from a boiler (11) to heat exchange; a dust collector (19) which removes particulate matter present in the exhaust gas (12); a wet-type desulfurization device (21) which removes mercury oxide (Hg2+) present in the exhaust gas (12) by means of an alkali absorption liquid and which removes sulfur oxides present in the exhaust gas; and an HBr compound supply means (50) which supplies HBr, which is a Br compound, to a

(57) **Abrégé(suite)/Abstract(continued):**

flue (13) that discharges exhaust gas from a boiler outlet. The concentration of bromine in the alkali absorption liquid in the wet-type desulfurization device (21) is increased to a prescribed concentration or higher. Consequently, mercury present in the exhaust gas is stabilized in the form of Hg2+ ions in a gypsum slurry solution discharged from the wet-type desulfurization device (21).

ABSTRACT

The present invention is a removal system for mercury in the flue gas configured to remove Hg contained in a flue gas flowing from a boiler, and includes: a heat exchanger (AH) 18 configured to execute heat exchange for a flue gas 12 flowing from a boiler 11; a precipitator 19 configured to remove soot dust in the flue gas 12; a wet SOx removal unit 21 configured to remove mercury oxide Hg^{2+} in the flue gas by alkali absorbent and desulfurize sulfur oxide in the flue gas; and an HBr compound supply unit 50 configured to supply HBr, namely, a Br compound into a flue gas duct 13 configured to discharge a flue gas from a boiler outlet. Further, enrichment of bromine contained in the alkali absorbent inside the wet SOx removal unit 21 is set to predetermined enrichment or higher. With this configuration, mercury in the flue gas is stabilized in an ionic state of Hg^{2+} in gypsum slurry solution discharged from the wet SOx removal unit 21.

DESCRIPTION

TREATMENT SYSTEM FOR MERCURY IN FLUE GAS

Field

[0001] The present invention relates to a treatment system for mercury in a flue gas, capable of removing mercury in the flue gas down to extremely low enrichment.

Background

[0002] A flue gas of coal combustion and a flue gas generated at the time of burning heavy oil may contain metal mercury (Hg^0) in addition to soot dust, sulfur oxide (SOx), nitrogen oxide (NOx). In recent years, various kinds of methods and apparatuses are invented to treat metal mercury (Hg^0) by combining an NOx removal unit configured to reduce NOx and a wet SOx removal unit in which alkali absorbent is used as SOx absorbent.

[0003] As the method of treating metal mercury (Hg^0) in the flue gas, there is a proposed method in which NH_4Cl solution is sprayed in a liquid state to the inside of a flue gas duct, and supplied into the flue gas duct in an upstream process of an NOx removal unit (for example, refer to Patent Literatures 1 and 2). When NH_4Cl solution is sprayed into the flue gas duct in the liquid state, NH_4Cl dissociates and generates an ammonium (NH_3) gas and a hydrogen chloride (HCl) gas. The NH_3 gas behaves as a reducing agent, and the HCl gas behaves as a mercury chlorination agent. More specifically, on a denitrification catalyst filled in the NOx removal unit, reduction reaction progresses between NH_3 and NOx in the flue gas as shown in a following Formula (1), and oxidation reaction progresses between HCl and Hg^0 in the flue gas as shown in a following Formula (2). NH_3 is reduced and denitrated, and also the metal mercury (Hg^0) is oxidized on the denitrification catalyst, and water-soluble mercury chloride ($HgCl_2$) is generated. Then, $HgCl_2$ is dissolved in gypsum slurry solution to remove mercury contained in the flue gas by the SOx removal unit according to a wet limestone-gypsum method provided on a downstream side.

$$4NO+4NH_3+O_2 \rightarrow 4N_2+6H_2O \quad (1)$$

$$Hg^0+1/2O_2+2HCl \rightarrow HgCl_2+H_2O \quad (2)$$

Citation List

Patent Literature

[0004] Patent Literature 1: Japanese Patent Application Laid-open No. 2008-142602

Patent Literature 2: Japanese Patent Application Laid-open No. 2009-202107

Summary

Technical Problem

[0005] Meanwhile, according to the proposal of removing mercury in the flue gas in the related arts, a part of mercury oxide (Hg^{2+}) that has been absorbed and removed may be reduced to metal mercury (Hg^0) and emitted from a stack in the same manner in the case where the absorbent in the wet SOx removal unit comes to have a reducing atmosphere again.

[0006] According to the proposal of removing mercury in the flue gas in the related arts, oxidation-reduction potential of the absorbent is controlled to prevent mercury from being emitted due to reduction.

[0007] The present invention is achieved in view of the above-described situation, and directed to providing a treatment system for mercury in a flue gas, in which mercury in the flue gas removed by the SOx removal unit can be selectively stabilized in a solid phase or a liquid phase.

Solution to Problem

[0008] According to a first aspect of the present invention in order to solve the above-mentioned problems, there is provided a treatment system for mercury in a flue gas, which is a system to remove Hg contained in the flue gas flowing from a boiler, including: a heat exchanger configured to execute heat exchange for the flue gas flowing from the boiler; a precipitator configured to remove soot dust in the flue gas; a wet SOx removal unit configured to remove mercury oxide Hg^{2+} in the flue gas with alkali absorbent and also desulfurize sulfur oxide in the flue gas; and a Br compound supply unit configured to supply a Br compound into the flue gas or into the alkali absorbent of the wet SOx removal unit, wherein enrichment of bromine inside the alkali absorbent in the wet SOx removal unit is set to predetermined enrichment or higher.

[0009] According to a second aspect of the present invention, there is provided the treatment system for mercury in a flue gas according to the first aspect, including an NOx removal unit disposed on an upstream side of the heat exchanger and provided with a denitrification catalyst configured to denitrate NOx in the flue gas and oxidize metal mercury (Hg^0).

[0010] According to a third aspect of the present invention, there is provided the treatment system for mercury in a flue gas according to the first or second aspect, wherein the alkali absorbent is limestone slurry, and a water separator configured to draw off limestone-gypsum slurry generated in the wet SOx removal unit and separate gypsum from the drawn-off limestone-gypsum slurry is provided.

[0011] According to a fourth aspect of the present invention, there is provided the treatment system for mercury in a flue gas according to the third aspect, wherein flocculation treatment is applied to solid content contained inside separate liquid after the gypsum separation, and a floc is separated, and further treated liquid obtained after separation is reused in the wet SOx removal unit or applied with wastewater treatment.

[0012] According to a fifth aspect of the present invention, there is provided the treatment system for mercury in a flue gas according to the third aspect, wherein mercury contained inside the separate liquid after the gypsum separation is separated as a gas body at a heating mercury separation device, and mercury contained inside emitted gas is scavenged by a scavenging unit.

Advantageous Effects of Invention

[0013] According to the present invention, enrichment of bromine in alkali absorbent inside the wet SOx removal unit is set to predetermined enrichment or higher. By thus setting the enrichment of bromine to the predetermined enrichment or higher, the mercury is kept in an Hg^{2+} ionic state inside the alkali absorbent such as gypsum slurry solution discharged from the SOx removal unit, and mercury in the flue gas can be stabilized in the liquid phase.

Brief Description of Drawings

[0014] FIG. 1 is a schematic diagram illustrating a treatment system for mercury in a flue gas according a first embodiment of the present invention.

FIG. 2 is a schematic diagram illustrating a treatment system for mercury in a flue gas according a second embodiment of the present invention.

FIG. 3 is a schematic diagram illustrating a treatment system for mercury in a flue gas according a third embodiment of the present invention.

FIG. 4 is a schematic diagram illustrating a treatment system for mercury in a flue gas according a fourth embodiment of the present invention.

FIG. 5 is a schematic diagram illustrating a treatment system for mercury in a flue gas according a fifth embodiment of the present invention.

FIG. 6 is a schematic diagram illustrating a treatment system for mercury in a flue gas according a sixth embodiment of the present invention.

FIG. 7 is a diagram illustrating a relation between enrichment of Br in slurry absorbent and enrichment of Hg in gypsum.

Description of Embodiments

[0015] Preferred embodiments of the present invention will be described with reference to the attached drawings. Note that the present invention is not limited to the embodiments and is intended to include configurations in which the respective embodiments are combined in the case where there is a plurality of embodiments.

[First Embodiment]

[0016] FIG. 1 is a schematic diagram illustrating a treatment system for mercury in a flue gas according to a first embodiment of the present invention.

As illustrated in FIG. 1, a treatment system for mercury in a flue gas 10A according to the present embodiment is a treatment system for mercury in the flue gas configured to remove mercury contained in a flue gas 12 flowing from a boiler 11, and includes: an NOx removal unit 17 configured to denitrate nitrogen oxide (NOx) in the flue gas 12 flowing from the boiler 11 where fuel F is supplied and burned by the boiler; a heat exchanger (AH) 18 disposed on a downstream side of the NOx removal unit 17 and configured to adjust a flue gas temperature; a precipitator 19 disposed on a downstream side of the heat exchanger 18 and configured to remove soot dust in the flue gas 12; a wet SOx removal unit 21 configured to remove mercury oxide Hg^{2+} in the flue gas 12 by using alkali absorbent, and also desulfurize sulfur oxide in the flue gas 12; and an HBr supply unit 50 configured to supply HBr, namely, a Br compound into a flue gas duct 13 where the flue gas 12 is discharged from a boiler outlet. Further, enrichment of bromine inside the alkali absorbent in the wet SOx removal unit 21 is set to predetermined enrichment or higher.

Here, in FIG. 1, a reference sign 13 represents the flue gas duct from which the flue gas 12 is discharged, and 25 represents the stack from which the purged flue gas 12 is discharged to the outside, and V_1, V_2, V_3 represent valves.

[0017] According to the present embodiment, ammonia (NH_3) solution 14A is supplied, as a denitration aid, from an ammonia (NH_3) solution supply unit 16A into the flue gas 12 flowing in the flue gas duct 13 via an ammonia (NH_3) supply line 15A on a previous stage side of the NOx removal unit 17.

Further, NOx in the flue gas 12 is reduced with a NH_3 by a denitrification catalyst.

For the NOx removal unit 17, a general unit including a reducing and denitrating catalyst can be used. The reducing and denitrating catalyst is not specifically limited, but for example, a catalyst in which metal oxide of W, Sn, In, Co, Ni, Fe, Ni, Ag, Cu, etc. is supported on a carrier such as zeolite can be used.

[0018] The NH_3 solution 14A is supplied, via the ammonia (NH_3) solution supply line 15A, from the NH_3 solution supply unit 16A to the flue gas 12 discharged from the boiler 11.

[0019] Preferably, a temperature of the flue gas 12 in the flue gas duct 13 is, for example, 320°C or more and 420°C or less, but more preferably, 320°C or more and the 380°C or less although it depends on combustion conditions at the boiler 11. The reason is that NOx denitration reaction on the denitrification catalyst can be effectively performed in this temperature range.

[0020] In the NOx removal unit 17, the supplied NH_3 gas is used to reduce and denitrate NOx.

[0021] More specifically, NH_3 gas reduces and denitrates NOx on the denitrification catalyst charged into a denitrification catalyst layer filled in the NOx removal unit 17 as shown in a following formula (1).

$4NO+4NH_3+O_2 \rightarrow 4N_2+6H_2O$ ... (1)

[0022] As for the flue gas 12, NOx in the flue gas 12 is reduced at the NOx removal unit 17, and then the temperature of the flue gas 12 is decreased by the heat exchanger 18.

[0023] After that, the flue gas 12 is passed through the precipitator (e.g., ESP) 19 and fed to the wet SOx removal unit 21. Further, a heat recovery device may be disposed between the heat exchanger 18 and the precipitator 19.

[0024] Next, after dust removal at the precipitator (ESP) 19, the flue gas 12 is fed to the wet SOx removal unit 21 for desulfurization treatment.

[0025] In the wet SOx removal unit 21, the flue gas 12 is fed from a wall surface side of a unit bottom portion 21b of a unit body 21a, and limestone-gypsum slurry 20 to be used as the alkali absorbent is supplied into the unit body 21a via an absorbent feed line L_1 and jetted from a nozzle 21c to a top portion side of the unit. The flue gas 12 flowing up from the unit bottom portion 21b side inside the unit body 21a is made gas-liquid contact with the limestone-gypsum slurry 20 jetted from the nozzle 21c and flowing down in an opposing manner, and $HgCl_2$ and sulfur oxide (SOx) in the flue gas 12 are absorbed into the limestone-gypsum slurry 20 and separated and removed from the flue gas 12. As a result, the flue gas 12 is purged. The flue gas 12 purged by the limestone-gypsum slurry 20 is discharged from the unit top portion side, and then discharged from a stack 25 outside the system as a purged gas 24.

Note that limestone 26 refilled into the unit body 21a is supplied from a limestone supply unit 27.

[0026] The limestone-gypsum slurry 20 used for desulfurization in the flue gas 12 is generated by mixing limestone ($CaCO_3$) slurry, gypsum ($CaSO_4$) slurry, and water The limestone ($CaCO_3$) is obtained by dissolving limestone powder in water, and the gypsum ($CaSO_4$) slurry is obtained by reacting the limestone 26 with SOx in the flue gas 12 and further executing oxidation. For the limestone-gypsum slurry 20, liquid stored in the unit bottom portion 21b of the unit body 21a of the wet SOx removal unit 21 is pumped up and used, for example. Inside the unit body 21a, SOx in the flue gas 12 is reacted with the limestone ($CaCO_3$) inside the limestone-gypsum slurry 20 as shown in a following formula (3).

$$CaCO_3+SO_2+0.5H_2O \rightarrow CaSO_3\cdot 0.5H_2O+CO_2 \quad (3)$$

[0027] On the other hand, the limestone-gypsum slurry 20 having absorbed SOx in the flue gas 12 is mixed with water 30 supplied into the unit body 21a, and oxidation treatment is applied by using air, namely, an oxidizing agent 55 supplied to the unit bottom portion 21b of the unit body 21a. At this point, the limestone-gypsum slurry 20 flowing down inside the unit body 21a is reacted with the water 30 and the air as shown in a following formula (4).

$$CaSO_3\cdot 0.5H_2O+0.5O_2+1.5H_2O \rightarrow CaSO_4\cdot 2H_2O \quad (4)$$

Thus, SO_x in the flue gas 12 is caught in a form of gypsum $CaSO_4\cdot 2H_2O$ in the wet SOx removal unit 21.

At this point, mercury bromide ($HgBr_2$) in the flue gas 12 is soluble in water, and therefore, is transferred to the limestone-gypsum slurry 20 side.

[0028] Thus, the removal system for mercury in the flue gas 10A according to the present embodiment is a removal system for mercury in the flue gas configured to remove Hg contained in the flue gas 12 discharged from the boiler, and includes: the heat exchanger (AH) 18 configured to execute heat exchange for the flue gas 12 discharged from the boiler 11; the precipitator 19 configured to remove the soot dust in the flue gas 12; and the wet SOx removal unit 21 configured to remove mercury oxide Hg^{2+} in the flue gas 12 with the alkali absorbent, and also desulfurize sulfur oxide in the flue gas 12. Further, the enrichment of bromine inside the alkali absorbent is controlled to be the predetermined enrichment or higher inside the wet SOx removal unit 21. As a result, mercury Hg^{2+} is stabilized in an ionic state in the solution of the limestone-gypsum slurry 20 discharged from the wet SOx removal unit 21 by setting the enrichment of bromine to the predetermined enrichment or higher.

[0029] In other words, HBr supplied from the HBr supply unit 50 is introduced into the wet SOx removal unit 21 in a state that HBr having the predetermined enrichment is contained in the flue gas 12. Therefore, reaction in a following formula (5) progresses in a leftward direction inside the slurry absorbent, and mercury exists in the ionic state. As a result, mercury can be stabilized in a liquid phase.

$$Hg^{2+}+SO_4^{2-} \Leftrightarrow HgSO_4 \qquad (5)$$

[0030] Meanwhile, FIG. 7 is a diagram illustrating a relation between the enrichment of Br in the slurry absorbent and enrichment of Hg in the gypsum.

As illustrated in FIG. 7, in the case where the enrichment of Br contained inside a total dissolved substance (TDS) of the liquid phase is high, the enrichment of Hg in the gypsum becomes low, and it is confirmed that in the case where a value of the enrichment of Br/TDS is equal to 0.33 or more, the enrichment of Hg becomes substantially zero (0.01 ppm).

Further, in the case where the value of the enrichment of Br/TDS is equal to 0.25 or more, the enrichment of Hg becomes 0.2 ppm. Therefore, mercury content inside the gypsum particle is infinitesimal.

[0031] According to the present embodiment, the enrichment of Br inside the limestone-gypsum slurry 20 at the unit bottom portion of the wet SOx removal unit 21 is measured by a Br enrichment meter 60. Further, based on a measurement result thereof, the state is held as it is in the case where the predetermined enrichment is kept.

Further, in the case where the enrichment of Br becomes the predetermined enrichment or lower, control to adjust an opening degree of a valve V_6 is executed by a control unit 61 so as to increase a supply amount of HBr supplied from the HBr supply unit 50.

In contrast, in the case where the enrichment of Br exceeds the predetermined enrichment, control to adjust an opening level of the valve V_5 interposed on a line L_3 is executed by the control unit 61 so as to return, to the unit bottom portion side of the wet SOx removal unit 21, separate liquid 34 separated from a later-described water separator 33.

[0032] As a result of this control, the enrichment of Br having an appropriate volume can be constantly kept, and mercury in the flue gas 12 and removed by the SOx removal unit can be stabilized in the liquid phase.

[0033] Further, oxidation-reduction potential of the limestone-gypsum slurry 20 in the wet SOx removal unit 21 is kept within a constant range. The reason is to prevent mercury oxide (Hg^{2+}) inside the limestone-gypsum slurry 20 from being reduced with the metal mercury (Hg^0) by SO_2 or the like as shown in a following formula (6), and prevent mercury from being re-scattered.

$$Hg^{2+}+2e^- \Leftrightarrow Hg^0 \qquad (6)$$

For a unit to keep the oxidation-reduction potential of the limestone-gypsum slurry 20 constant, an ORP controller 56 configured to control the oxidation-reduction potential (ORP) of the limestone-gypsum slurry 20 is used. For example, a supply amount of the oxidizing agent 55 is adjusted such that the oxidation-reduction potential becomes preferably 200 mV or higher, and more preferably, 600 mV or higher.

As a result, mercury oxide dissolved in the limestone-gypsum slurry 20 is prevented from becoming metal mercury and re-scattered, and also mercury is prevented from being entrained in the flue gas 12.

[0034] The limestone-gypsum slurry 20 stored in the unit bottom portion 21b of the wet SOx removal unit 21 and used for desulfurization is drawn off from the unit bottom portion 21b after being oxidized. The drawn-off limestone-gypsum slurry 20 is fed to the water separator 33 via a line L_2, and then discharged outside the system as a dehydrated cake (gypsum) 28 containing mercury bromide ($HgBr_2$).

[0035] For the water separator 33, a belt filter or the like may be used, for example.

[0036] A method of supplying the limestone-gypsum slurry 20 is not limited to the method of jetting from the nozzle 21c toward the unit top portion side. For example, the limestone-gypsum slurry may be flown downward from the nozzle 21c so as to be opposed to the flue gas 12.

[0037] According to the present embodiment, HBr is entrained in the flue gas 12 to be introduced into the wet SOx removal unit 21. Therefore, mercury oxide in the flue gas 12 is dissolved into the absorbent in the ionic state, and mercury can be stabilized in the liquid phase.

[0038] The separate liquid 34 containing mercury separated at the water separator 33 is introduced via the line L_3 into a flocculation unit 35 in which flocculation treatment is applied to a floc contained in the mercury absorbent.

In the flocculation unit 35, for example, a flocculation treatment agent 36 like flocculant such as a heavy metal scavenger and a chelate agent is added, and the flocculation treatment is applied to a floc 37 containing mercury inside the separate liquid 34 containing mercury.

[0039] For the flocculation treatment agent 36, for example, Fe-based flocculant, Al-based flocculant, polymer-based flocculant, etc. can be exemplified.

When the flocculation treatment is applied, mercury oxide inside the separate liquid 34 containing mercury is flocculated, thereby transferring mercury from the liquid phase to the solid phase.

[0040] Evaporation treatment is separately applied to the floc 37 in the flocculation unit 35 by an evaporation treatment unit, thereby applying treatment to eliminate wastewater.

[0041] Further, a dehydration treatment device 38 configured to dehydrate the floc 37 and separate a solid from liquid may also be provided to perform dehydration treatment and separate the floc into sludge 39 and treated water 40.

Then, since the sludge 39 as a dehydration product contains mercury, the sludge 39 is treated separately.

Further, the treated water 40, namely, filtrate may be reused as dilution liquid for the limestone 26 at the limestone supply unit 27. Also, the treated water 40 may be utilized as a part of the water 30 to be supplied into the unit body 21a.

[0042] Moreover, for example, the treatment to eliminate the wastewater may be applied to the treated water 40 so as to evaporate the treated water 40 besides reusing the treated water 40. Also, the treated water 40 may be transferred to a wastewater treatment device 41, and operation such as removing a suspended solid and a heavy metal 42 contained inside the treated water 40 and adjusting pH of the filtrate obtained from dehydration may be performed by the wastewater treatment device 41.

A part of wastewater 43 for which the wastewater treatment has been applied at the wastewater treatment device 41 is returned to the wet SOx removal unit 21, and a remaining part is treated as discharging water.

[Second Embodiment]

[0043] Next, a treatment system for mercury in a flue gas according to a second embodiment of the present invention will be described. Note that components same as those of a first embodiment are denoted by the same reference signs and repetition of a description therefor will be omitted.

FIG. 2 is a schematic diagram illustrating the treatment system for mercury in a flue gas according to the second embodiment of the present invention.

As illustrated in FIG. 2, a treatment system for mercury in the flue gas 10B according to the present embodiment is configured to supply HBr into limestone-gypsum slurry 20 of the SOx removal unit 21 from an HBr supply unit 50 instead of supplying HBr into a flue gas 12 in a treatment system for mercury in the flue gas 10A of the first embodiment. This increases enrichment of HBr inside the limestone-gypsum slurry 20.

[0044] As a result, HBr having enrichment equal to predetermined enrichment or higher is contained inside slurry absorbent. Therefore, since reaction in a following formula (5) progresses in a leftward direction and mercury exists in an ionic state, mercury can be stabilized in a liquid phase.

$$Hg^{2+}+SO_4^{2-} \Leftrightarrow HgSO_4 \qquad (5)$$

[0045] According to the present embodiment, enrichment of bromine inside alkali absorbent in the wet SOx removal unit 21 is increased to the predetermined enrichment or higher by additionally supplying HBr from the HBr supply unit 50. By thus setting the enrichment of bromine to the predetermined enrichment or higher, mercury in the flue gas 12 can be stabilized in an ionic state Hg^{2+}, for example, inside solution of limestone-gypsum slurry 20 which is the alkali absorbent discharged from the wet SOx removal unit 21.

[0046] According to the present embodiment, the enrichment of Br in the limestone-gypsum slurry 20 at a unit bottom portion of the wet SOx removal unit 21 is measured by a Br enrichment meter 60. Further, based on a measurement result thereof, the state is held as it is in the case where the predetermined enrichment is kept.

Further, in the case where the enrichment of Br becomes the predetermined enrichment or lower, control to adjust an opening degree of a valve V_6 is executed by a control unit 61 so as to increase a supply amount of HBr supplied from the HBr supply unit 50.

In contrast, in the case where the enrichment of Br exceeds the predetermined enrichment, control to adjust an opening level of a valve V_5 interposed on a line L_3 is executed by the control unit 61 so as to return separate liquid 34 separated at a water separator 33 to a unit bottom portion side of the wet SOx removal unit 21.

[0047] As a result of this control, the enrichment of Br having an appropriate volume can be constantly kept, and mercury in the flue gas 12 and removed by the SOx removal unit can be stabilized in the liquid phase.

[Third Embodiment]

[0048] Next, a treatment system for mercury in a flue gas according to a third embodiment of the present invention will be described. Note that components same as those of first and second embodiments are denoted by the same reference signs and repetition of a description therefor will be omitted.

FIG. 3 is a schematic diagram illustrating the treatment system for mercury in the flue gas according to the third embodiment of the present invention.

As illustrated in FIG. 3, a treatment system for mercury in a flue gas 10C supplies, as a denitration aid, ammonium bromide (NH_4Br) solution 14B into a flue gas 12 flowing in a flue gas duct 13 via an ammonium bromide (NH_4Br) supply line 15B from an ammonium bromide (NH_4Br) solution supply unit 16B in a previous stage side of an NOx removal unit 17.

Further, NOx in the flue gas 12 is reduced by NH_3 gas and also metal mercury (Hg^0) is oxidized by a denitrification catalyst in coexistence of an HBr gas.

For the NOx removal unit 17, a general unit including a reducing and denitrating catalyst can be used. The reducing and denitrating catalyst is not specifically limited, but for example, a catalyst in which metal oxide of W, Sn, In, Co, Ni, Fe, Ni, Ag, Cu, etc. is supported on a carrier such as zeolite can be used. An amount of the reducing and denitrating catalyst included in the NOx removal unit 17 may be increased more than a normal amount in order to improve mercury oxidation efficiency.

[0049] According to the present embodiment, the ammonium bromide (NH_4Br) solution 14B is used as an example, and an oxidation aid and a reduction aid are generated and also the flue gas 12 is made to contain HBr when the ammonium bromide (NH_4Br) solution 14B is vaporized.

Here, according to the present embodiment, an aid that functions as an oxidation aid used to oxidize metal mercury (Hg^0) in coexistence of an oxidation aid and also functions as a reducing agent to reduce NOx with a reduction aid is referred to as a reduction and oxidation aid. According to the present embodiment, the HBr gas is used as the oxidation aid, and NH_3 gas is used as the reduction aid.

Note that the oxidation aid (e.g., HBr gas) and the reduction aid (e.g., NH_3 gas) may be separately introduced as well.

[0050] The NH_4Br solution 14B is supplied, via the ammonium bromide (NH_4Br) solution supply line 15B, from the NH_4Br solution supply unit 16B into the flue gas 12 discharged from the boiler 11.

[0051] Droplets of the NH_4Br solution 14B sprayed into the flue gas duct 13 from the NH_4Br solution supply unit 16B are evaporated and vaporized due to a high atmospheric temperature of the flue gas 12, and fine solid particles of NH_4Br are generated and decomposed into HBr and NH_3 as shown in a following formula (7). Therefore, NH_4Br solution 14B sprayed from a spray unit is decomposed and HBr and NH_3 are generated, and then the NH_3 gas and the HBr gas are supplied into the flue gas duct 13.

$$NH_4Br \rightarrow NH_3+HBr \qquad (7)$$

[0052] Preferably, a temperature of the flue gas 12 in the flue gas duct 13 is, for example, 320°C or more and 420°C or less, but more preferably, 320°C or more and the 380°C or less although it depends on combustion conditions at the boiler 11. The reason is that denitration reaction of NOx and oxidation reaction of Hg can be effectively achieved on the denitrification catalyst in this temperature range.

[0053] Further, the flue gas 12 is fed to the NOx removal unit 17 after containing the HBr gas and the NH_3 gas generated from the droplets of the NH_4Br solution 14B sprayed from the NH_4Br solution supply unit 16B into the flue gas duct 13. In the NOx removal unit 17, the NH_3 gas generated by decomposing NH_4Br is used to reduce and denitrate NOx, and the HBr gas is used to oxidize Hg, and NOx and Hg are removed from the flue gas 12. Therefore, a mercury removal rate is more improved than the case of using ammonia.

[0054] More specifically, on the denitrification catalyst charged into a denitrification catalyst layer filled in the NOx removal unit 17, the NH_3 gas reduces and denitrates NOx as shown in a following formula (1) and Hg is oxidized by the HBr gas as shown in a following formula (8).

$$4NO+4NH_3+O_2 \rightarrow 4N_2+6H_2O \qquad (1)$$

$$Hg+1/2O_2+2HBr \rightarrow HgBr_2+H_2O \qquad (8)$$

[0055] The flue gas 12 is passed through a heat exchanger 18 and a precipitator (ESP) 19, and then fed to a wet SOx removal unit 21 after reducing NOx in the flue gas 12 and oxidizing Hg in the flue gas 12 at the NOx removal unit 17. Further, a heat recovery device may be disposed between the heat exchanger 18 and the precipitator (ESP) 19.

[0056] After that, SOx is desulfurized at the wet SOx removal unit 21, but at this point, since enrichment of Br inside limestone-gypsum slurry is set high, reaction in a following formula (5) progresses in a leftward direction in the slurry absorbent, and since mercury exists in an ionic state. As a result, mercury can be stabilized in a liquid phase.

$$Hg^{2+}+SO_4^{2-} \Leftrightarrow HgSO_4 \qquad (5)$$

[0057] Further, according to the present embodiment, it is not necessary to separately provide an HBr supply unit 50 configured to supply HBr like the first embodiment because, different from the first embodiment, the reducing agent and the oxidizing agent for denitrification are generated by using the ammonium bromide as the reducing and oxidizing agent used in the NOx removal unit 17 and further the flue gas 12 is introduced into the wet SOx removal unit 21 after being made to contain hydrogen bromide (HBr).

[0058] According to the present embodiment, the enrichment of Br inside the limestone-gypsum slurry 20 at the unit bottom portion of the wet SOx removal unit 21 is measured by a Br enrichment meter 60. Further, based on a measurement result thereof, the state is held as it is in the case where the predetermined enrichment is kept.

Further, in the case where the enrichment of Br becomes predetermined enrichment or lower, control to adjust an opening degree of a valve V_1 is executed by a control unit 61 so as to increase a supply amount of NH_4Br supplied from the ammonium bromide (NH_4Br) solution supply unit 16B.

In contrast, in the case where the enrichment of Br exceeds the predetermined enrichment, control to adjust an opening level of a valve V_5 interposed on a line L_3 is executed by the control unit 61 so as to return separate liquid 34 separated at a water separator 33 to a unit bottom portion side of the wet SOx removal unit 21.

[0059] As a result of this control, the enrichment of Br having an appropriate volume can be constantly kept, and mercury in the flue gas 12 and removed by the SOx removal unit can be stabilized in the liquid phase.

[Fourth Embodiment]

[0060] Next, a treatment system for mercury in a flue gas according to a fourth embodiment of the present invention will be described. Note that components same as those of first to third embodiments are denoted by the same reference signs and repetition of a description therefor will be omitted.

FIG. 4 is a schematic diagram illustrating the treatment system for mercury in the flue gas according to the fourth embodiment of the present invention.

As illustrated in FIG. 4, a treatment system for mercury in a flue gas 10D according the present embodiment includes a heating mercury separation device 80 configured to remove water from separate liquid 34 containing mercury separated at a water separator 33 of the first embodiment.

[0061] The heating mercury separation device 80 sprays the separate liquid 34 into the unit body 21a and also supplies steam 81 to the inside, and separates mercury as a gas state by heat of the steam 81, and the mercury in the gas body is transferred into an emitted gas 82.

[0062] Treated water 83 from which mercury is removed at the heating mercury separation device 80 is reused as make-up water.

[0063] Further, gas-like mercury transferred into the emitted gas 82 is introduced into, for example, to a mercury absorber 85 filled with activated carbon 84. Then, mercury is absorbed and removed with the activated carbon 84 inside the mercury absorber 85. Further, treated water 86 from which mercury is removed may be used for evaporation treatment or reused in a different way.

[Fifth Embodiment]

[0064] Next, a treatment system for mercury in a flue gas according to a fifth embodiment of the present invention will be described. Note that components same as those of first to fourth embodiments are denoted by the same reference signs and repetition of a description therefor will be omitted.

FIG. 5 is a schematic diagram illustrating the treatment system for mercury in the flue gas according to the fifth embodiment of the present invention.

As illustrated in FIG. 5, the treatment system for mercury in a flue gas 10E according the present embodiment supplies ammonium chloride instead of ammonium bromide used in a NOx removal unit 17 of the third embodiment.

According to the present embodiment, an ammonium chloride (NH_4Cl) solution supply unit 16C configured to spray NH_4Cl solution 14C containing ammonium chloride (NH_4Cl) as a reduction and oxidization aid; and a NOx removal unit 17 configured to reduce NOx in a flue gas 12 with NH_3 gas and also including a denitrification catalyst to oxidize metal mercury (Hg^0) in coexistence of an HCl gas are provided in a flue gas duct 13 at a downstream of a boiler 11.

[0065] According to the present embodiment, NH_4Cl is used as an example, but not limited thereto, any reduction and oxidization aid can be used as long as the reduction and oxidization aid is halide that generates an oxidation aid and a reduction aid when vaporized. Here, according to the present embodiment, an aid that functions as an oxidation aid used to oxidize metal mercury (Hg^0) in coexistence of an oxidation aid and also functions as a reducing agent to reduce NOx with a reduction aid is referred to as the reduction and oxidation aid. According to the present embodiment, HCl gas is used as the oxidization aid, and NH_3 gas is used as the reduction aid.

Further, the oxidization aid (e.g., HCl gas) and the reduction aid (e.g., NH_3 gas) may be separately introduced as well.

[0066] The NH_4Cl solution 14C is supplied from an NH_4Cl solution supply unit 16C via an ammonium chloride (NH_4Cl) supply line 15C to the flue gas 12 discharged from the boiler 11.

[0067] Droplets of the NH_4Cl solution 14C sprayed into the flue gas duct 13 from the NH_4Cl solution supply unit 16C are evaporated and vaporized due to a high atmospheric temperature of the flue gas 12, and fine solid particles of NH_4Cl are generated and decomposed into HCl and NH_3 as shown in a following formula (9). Therefore, the NH_4Cl solution 14C sprayed from a spray unit generates HCl and NH_3, and supplies the NH_3 gas and the HCl gas into the flue gas duct 13.

$$NH_4Cl \rightarrow NH_3+HCl \qquad (9)$$

[0068] Preferably, a temperature of the flue gas 12 in the flue gas duct 13 is, for example, 320°C or more and 420°C or less, but more preferably, 320°C or more and the 380°C or less although it depends on combustion conditions at the boiler 11. The reason is that denitration reaction of NOx and oxidation reaction of Hg can be effectively achieved on the denitrification catalyst in this temperature range.

[0069] Further, the flue gas 12 is fed to the NOx removal unit 17 after containing the HCl gas and the NH_3 gas generated from the droplets of the NH_4Cl solution 14C sprayed into the flue gas duct 13 from the NH_4Cl solution supply unit 16C. In the NOx removal unit 17, the NH_3 gas generated from decomposing NH_4Cl is used to reduce and denitrate NOx, and the HCl gas is used to oxidize Hg, and NOx and Hg are removed from the flue gas 12. Therefore, a mercury removal rate is more improved than the case of using ammonia.

[0070] More specifically, on the denitrification catalyst charged to a denitrification catalyst layer filled in the NOx removal unit 17, the NH_3 gas reduces and denitrates NOx as shown in a following formula (10) and Hg is oxidized by the HCl gas as shown in a following formula (11).

$$4NO+4NH_3+O_2 \rightarrow 4N_2+6H_2O \qquad (10)$$

$$Hg+1/2O_2+2HCl \rightarrow HgCl_2+H_2O \qquad (11)$$

[0071] The flue gas 12 lowers the temperature of the flue gas 12 by a heat exchanger 18 after reducing NOx in the flue gas 12 and oxidizing Hg in the flue gas 12 at the NOx removal unit 17.

[0072] Note that only ammonia may be supplied and nitrogen oxide in the flue gas 12 may be denitrated using ammonia by the NOx removal unit.

Further, in the case where an amount of nitrogen oxide in the flue gas 12 is little, flue gas treatment may be applied without providing the NOx removal unit. In this case, mercury oxidation, mercury is oxidized by halide (e.g., chloride) or the like contained in the flue gas 12.

[0073] Next, after dust removal at a precipitator 19, the flue gas 12 is fed to a wet SOx removal unit 21 for desulfurization treatment.

According to the present embodiment, HBr is supplied from an HBr supply unit 50 into limestone-gypsum slurry 20 of the wet SOx removal unit 21. This increases enrichment of HBr inside the limestone-gypsum slurry 20.

[0074] As a result, HBr having predetermined enrichment or more is contained inside slurry absorbent. Therefore, since reaction in a following formula (5) progresses in a leftward direction and mercury exists in an ionic state, mercury can be stabilized in a liquid phase.

$$Hg^{2+}+SO_4^{2-} \Leftrightarrow HgSO_4 \qquad (5)$$

[0075] According to the present embodiment, enrichment of bromine inside alkali absorbent in the wet SOx removal unit 21 is set to the predetermined enrichment or higher by separately supplying HBr from the HBr supply unit 50. By thus setting the enrichment of bromine to the predetermined enrichment or higher, mercury in the flue gas 12 can be stabilized in an ionic state Hg^{2+}, for example, inside solution of limestone-gypsum slurry 20 which is the alkali absorbent discharged from the wet SOx removal unit 21.

[0076] According to the present embodiment, the enrichment of Br inside the limestone-gypsum slurry 20 at the unit bottom portion of the wet SOx removal unit 21 is measured by a Br enrichment meter 60. Further, based on a measurement result thereof, the state is held as it is in the case where the predetermined enrichment is kept.

Further, in the case where the enrichment of Br becomes the predetermined enrichment or lower, control to adjust an opening degree of a valve V_1 or a valve V_6 is executed by a control unit 61 so as to increase a supply amount of NH_4Br supplied from the ammonium bromide (NH_4Br) solution supply unit 16B or increase a supply amount of HBr supplied from the HBr supply unit 50.

In contrast, in the case where the enrichment of Br exceeds the predetermined enrichment, control to adjust an opening level of the valve V_5 interposed on a line L_3 is executed by the control unit 61 so as to return separate liquid 34 separated at a water separator 33 to a bottom portion side of the wet SOx removal unit 21.

[0077] As a result of this control, the enrichment of Br having an appropriate volume can be constantly kept, and mercury in the flue gas 12 and removed by the SOx removal unit can be stabilized in the liquid phase.

[Six Embodiment]

[0078] Next, a treatment system for mercury in a flue gas according to a sixth embodiment of the present invention will be described. Note that components same as those of first to fifth embodiments are denoted by the same reference signs and repetition of a description therefor will be omitted.

FIG. 6 is a schematic diagram illustrating the treatment system for mercury in the flue gas according to the sixth embodiment of the present invention.

As illustrated in FIG. 6, a treatment system for mercury in a flue gas 10F according to the present embodiment supplies HBr from an HBr supply unit 50 into a flue gas duct 13 configured to introduce a flue gas 12 into a wet SOx removal unit 21, different from a fifth embodiment.

HBr having been introduced into the wet SOx removal unit 21 together with the flue gas 12 is dissolved into limestone-gypsum slurry 20, thereby increasing enrichment of HBr in the limestone-gypsum slurry 20 to predetermined enrichment or higher.

[0079] As a result, HBr is contained in slurry absorbent, and therefore reaction in a following formula (5) progresses in a leftward direction and mercury exists in an ionic state. Therefore, mercury can be stabilized in a liquid phase.

$$Hg^{2+}+SO_4^{2-} \Leftrightarrow HgSO_4 \qquad (5)$$

[0080] According to the present embodiment, HBr is separately supplied from the HBr supply unit 50 into the flue gas 12 introduced to the wet SOx removal unit 21, and enrichment of bromine inside alkali absorbent inside the wet SOx removal unit 21 is increased to predetermined enrichment or higher. By thus setting the enrichment of bromine to the predetermined enrichment or higher, mercury in the flue gas 12 can be stabilized in an ionic state Hg^{2+}, for example, inside solution of limestone-gypsum slurry 20 which is the alkali absorbent discharged from the wet SOx removal unit 21.

According to the present embodiment, the enrichment of Br inside the limestone-gypsum slurry 20 at the unit bottom portion of the wet SOx removal unit 21 is measured by a Br enrichment meter 60. Further, based on a measurement result thereof, the state is held as it is in the case where the predetermined enrichment is kept.

Additionally, in the case where the enrichment of Br becomes to the predetermined enrichment or lower, control to adjust an opening degree of a valve V_7 is executed by a control unit 61 so as to increase a supply amount of HBr supplied from the HBr supply unit 50.

In contrast, in the case where the enrichment of Br exceeds the predetermined enrichment, control to adjust an opening level of a valve V_5 interposed on a line L_3 is executed by the control unit 61 so as to return separate liquid 34 separated at a water separator 33 to a unit bottom portion side of the wet SOx removal unit 21.

[0081] As a result of this control, the enrichment of Br having an appropriate volume can be constantly kept, and mercury in the flue gas 12 and removed by the SOx removal unit can be stabilized in the liquid phase.

Reference Signs List

[0082]

10A - 10F	Treatment system for mercury in flue gas
11	Boiler
12	Flue gas
16A	NH_3 solution supply unit
16B	NH_4Br solution supply unit
16C	NH_4Cl solution supply unit
17	NOx removal unit
18	Heat exchanger (AH)
50	HBr supply unit
60	Br enrichment meter
61	Control unit

CLAIMS

1. A treatment system for mercury in a flue gas, which is a system to remove Hg contained in the flue gas flowing from a boiler, comprising:

a heat exchanger configured to execute heat exchange for the flue gas flowing from the boiler;

a precipitator configured to remove soot dust in the flue gas;

a wet SOx removal unit configured to remove mercury oxide Hg^{2+} in the flue gas with alkali absorbent and also desulfurize sulfur oxide in the flue gas; and

a Br compound supply unit configured to supply a Br compound into the flue gas or into the alkali absorbent of the wet SOx removal unit,

wherein enrichment of bromine inside the alkali absorbent in the wet SOx removal unit is set to predetermined enrichment or higher.

2. The treatment system for mercury in a flue gas according to claim 1, including an NOx removal unit disposed on an upstream side of the heat exchanger and provided with a denitrification catalyst configured to denitrate NOx in the flue gas and oxidize metal mercury (Hg^0).

3. The treatment system for mercury in a flue gas according to claim 1 or 2, wherein the alkali absorbent is limestone slurry, and a water separator configured to draw off limestone-gypsum slurry generated in the wet SOx removal unit and separate gypsum from the drawn-off limestone-gypsum slurry is provided.

4. The treatment system for mercury in a flue gas according to claim 3, wherein flocculation treatment is applied to solid content contained inside separate liquid after the gypsum

separation, and a floc is separated, and further treated liquid obtained after separation is reused in the wet SOx removal unit or applied with wastewater treatment.

5. The treatment system for mercury in a flue gas according to claim 3, wherein mercury contained inside the separate liquid after the gypsum separation is separated as a gas body at a heating mercury separation device, and mercury contained inside emitted gas is scavenged by a scavenging unit.

FIG.1

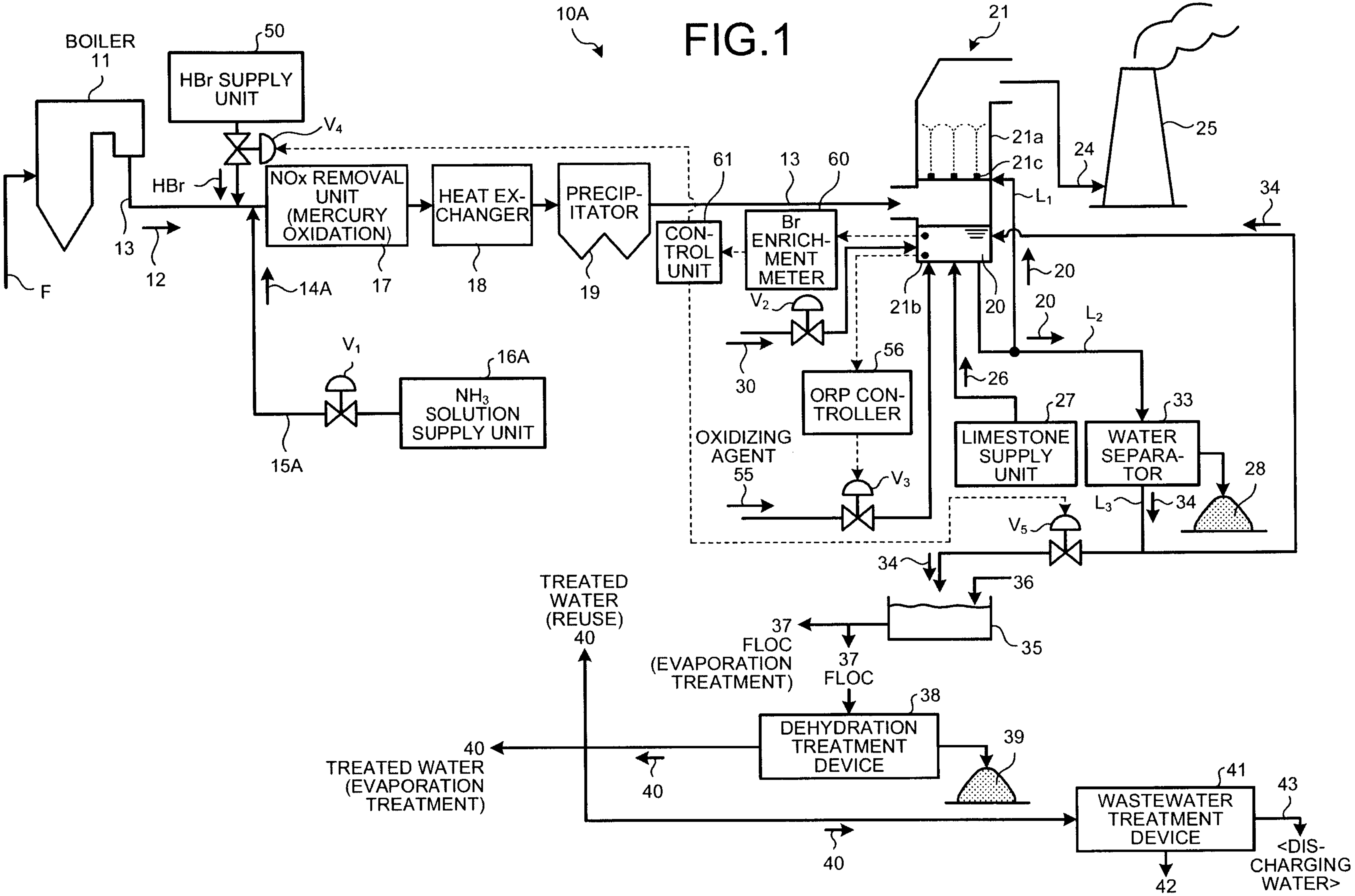

10A
BOILER
11
F
13
12
HBr
HBr SUPPLY UNIT
50
V4
14A
15A
V1
NH3 SOLUTION SUPPLY UNIT
16A
NOx REMOVAL UNIT (MERCURY OXIDATION)
17
HEAT EX-CHANGER
18
PRECIP-ITATOR
19
CON-TROL UNIT
61
Br ENRICH-MENT METER
60
13
V2
30
ORP CON-TROLLER
56
OXIDIZING AGENT
55
V3
21
21a
21c
21b
L1
20
20
20
L2
24
25
34
26
LIMESTONE SUPPLY UNIT
27
WATER SEPARA-TOR
33
28
L3
34
V5
34
36
35
37
FLOC (EVAPORATION TREATMENT)
37
FLOC
DEHYDRATION TREATMENT DEVICE
38
39
TREATED WATER (REUSE)
40
40
TREATED WATER (EVAPORATION TREATMENT)
40
40
WASTEWATER TREATMENT DEVICE
41
42
43
<DIS-CHARGING WATER>

FIG.2

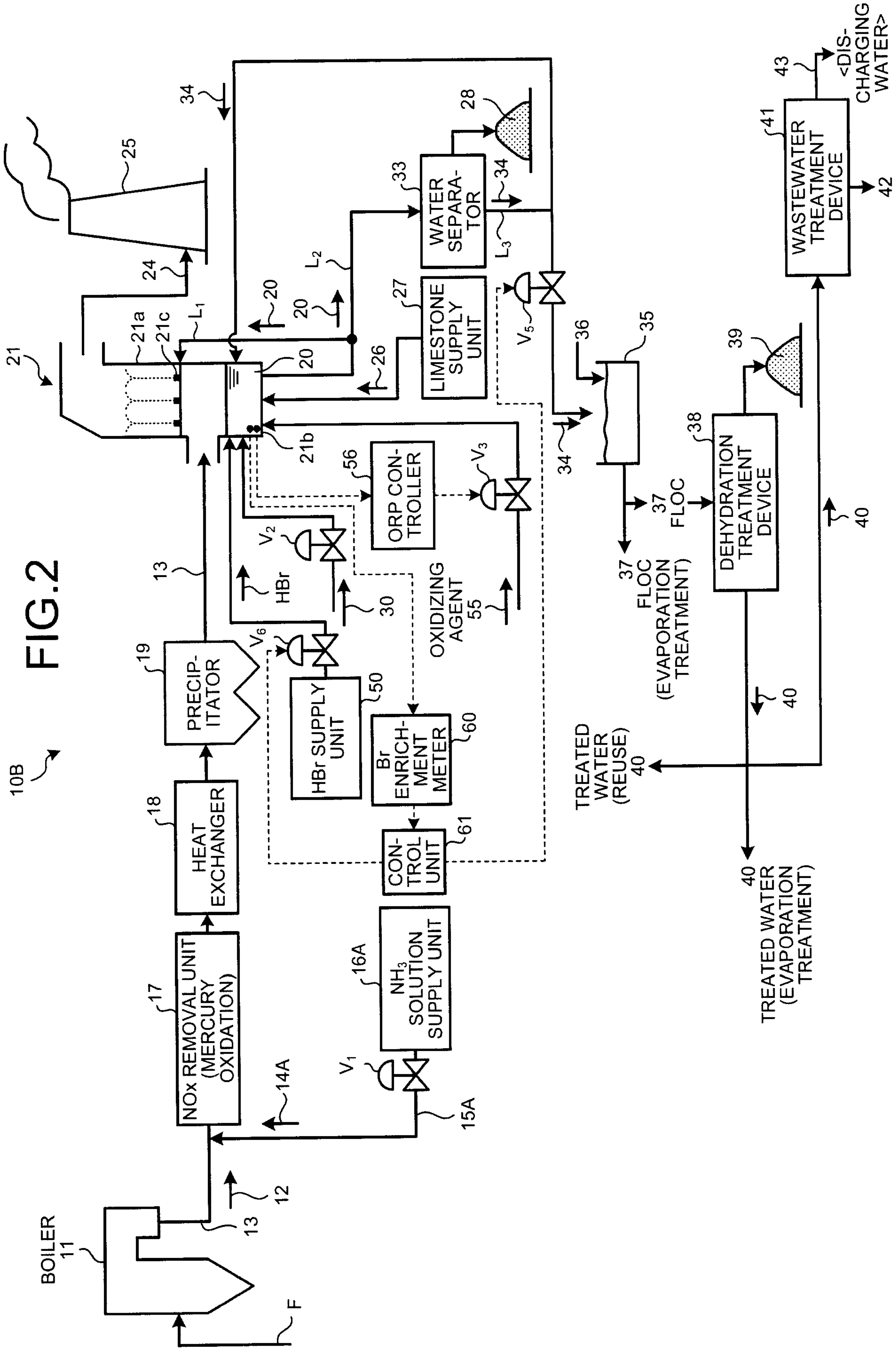

10B
BOILER
11
F
13
12
14A
15A
V1
NOx REMOVAL UNIT (MERCURY OXIDATION)
17
HEAT EXCHANGER
18
PRECIP-ITATOR
19
13
NH3 SOLUTION SUPPLY UNIT
16A
CON-TROL UNIT
61
Br ENRICH-MENT METER
60
HBr SUPPLY UNIT
50
V6
HBr
V2
30
ORP CON-TROLLER
56
V3
OXIDIZING AGENT
55
21
21a
21c
21b
L1
20
24
25
26
LIMESTONE SUPPLY UNIT
27
L2
WATER SEPARA-TOR
33
28
34
L3
V5
35
36
37
FLOC
FLOC (EVAPORATION TREATMENT)
DEHYDRATION TREATMENT DEVICE
38
39
40
TREATED WATER (REUSE)
TREATED WATER (EVAPORATION TREATMENT)
WASTEWATER TREATMENT DEVICE
41
42
43
<DIS-CHARGING WATER>

FIG.3

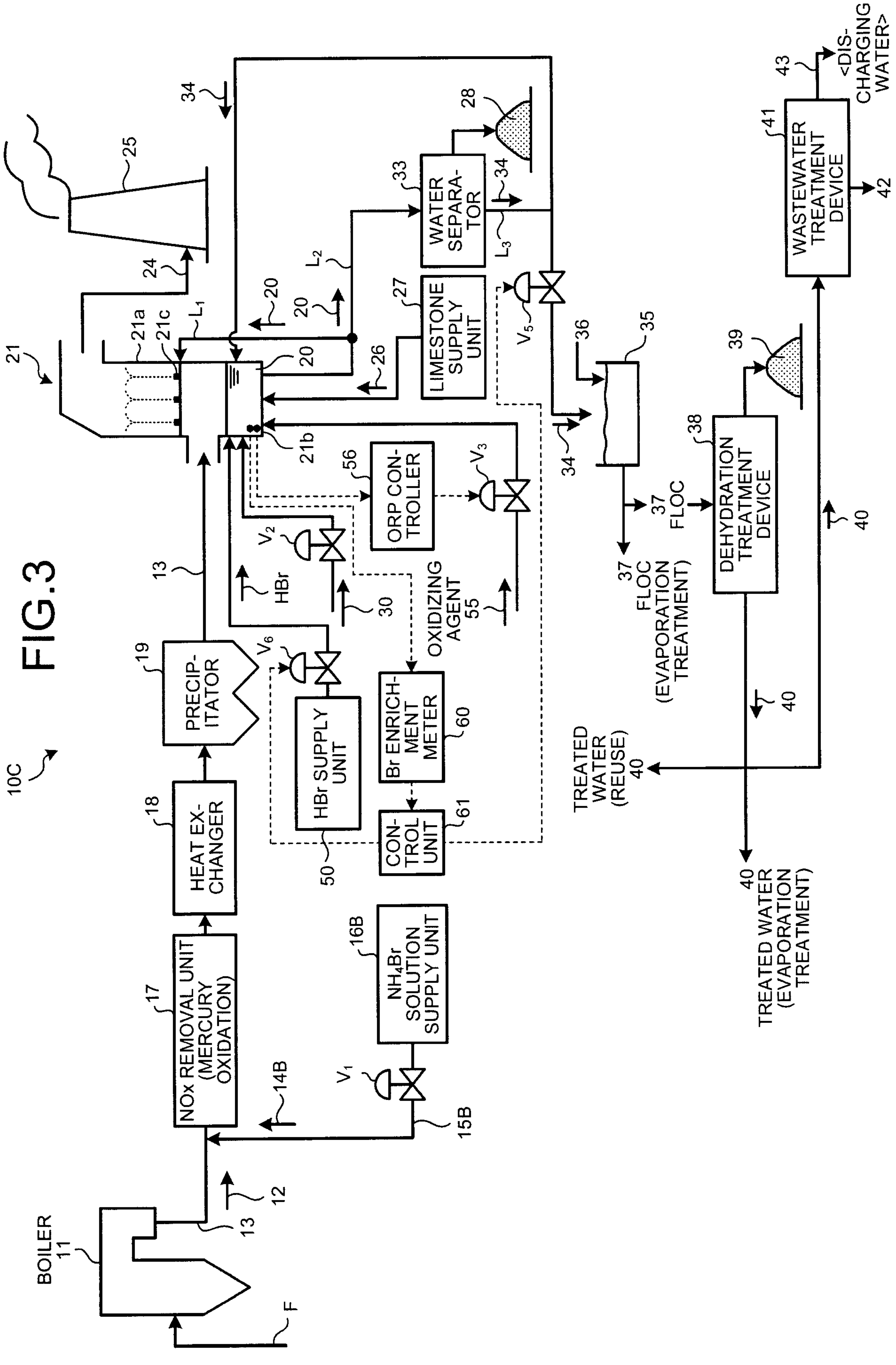

10C
BOILER
11
F
13
12
14B
15B
V1
NH4Br SOLUTION SUPPLY UNIT
16B
NOx REMOVAL UNIT (MERCURY OXIDATION)
17
HEAT EX-CHANGER
18
PRECIP-ITATOR
19
13
HBr SUPPLY UNIT
50
V6
HBr
V2
30
CON-TROL UNIT
61
Br ENRICH-MENT METER
60
ORP CON-TROLLER
56
V3
OXIDIZING AGENT
55
21
21a
21c
21b
L1
20
24
25
34
L2
26
27
LIMESTONE SUPPLY UNIT
WATER SEPARA-TOR
33
28
L3
V5
36
35
37 FLOC
37 FLOC (EVAPORATION TREATMENT)
38
DEHYDRATION TREATMENT DEVICE
39
40
TREATED WATER (REUSE)
TREATED WATER (EVAPORATION TREATMENT)
41
WASTEWATER TREATMENT DEVICE
42
43
<DIS-CHARGING WATER>

FIG.4

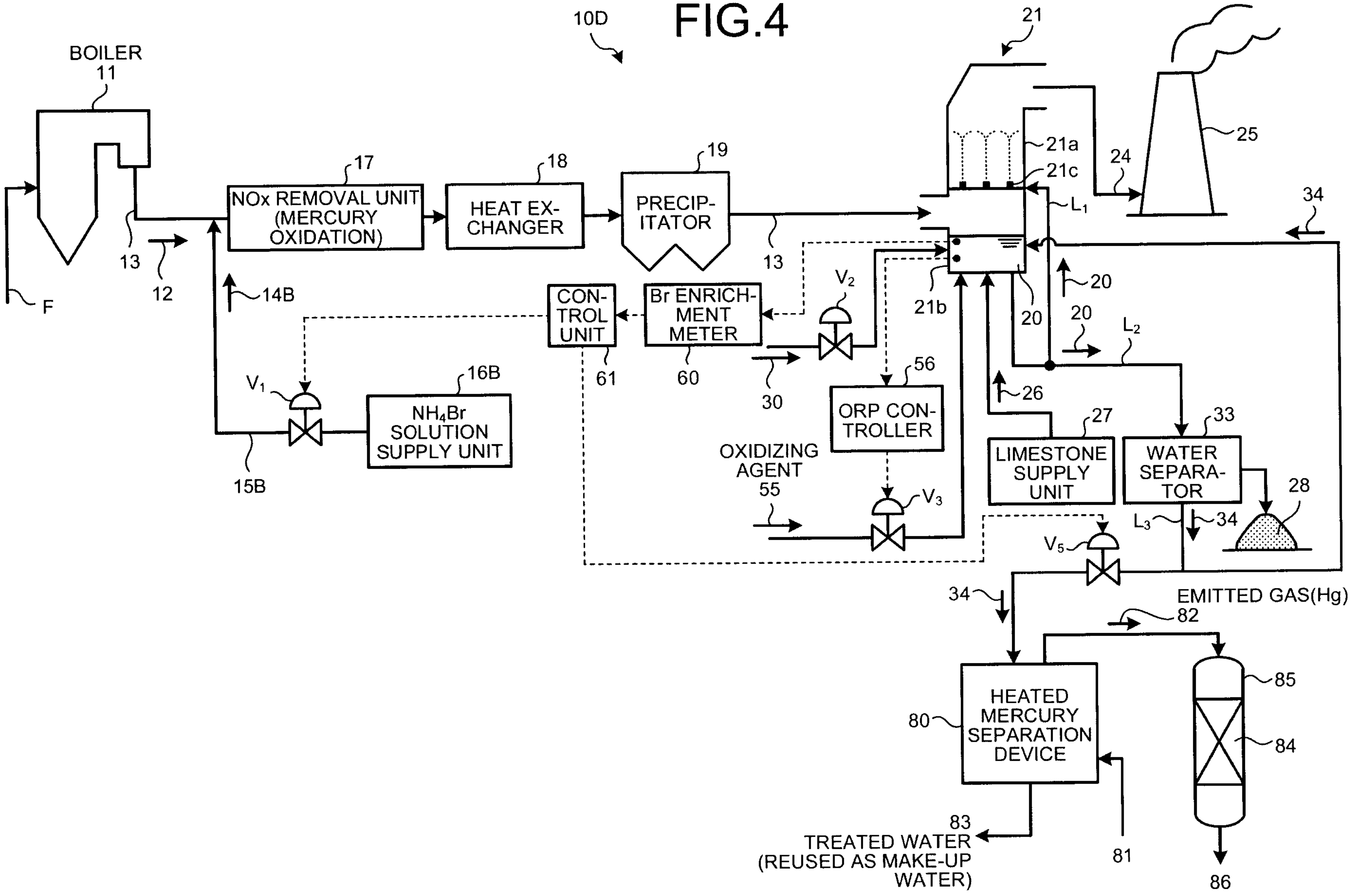

10D
BOILER
11
F
13
12
14B
15B
V1
16B
NH4Br SOLUTION SUPPLY UNIT
17
NOx REMOVAL UNIT (MERCURY OXIDATION)
18
HEAT EX-CHANGER
19
PRECIP-ITATOR
13
CON-TROL UNIT
61
Br ENRICH-MENT METER
60
30
V2
56
ORP CON-TROLLER
OXIDIZING AGENT 55
V3
21
21a
21c
L1
21b
20
20
20
L2
24
25
34
26
27
LIMESTONE SUPPLY UNIT
33
WATER SEPARA-TOR
28
L3
34
V5
34
EMITTED GAS(Hg)
82
80
HEATED MERCURY SEPARATION DEVICE
81
83
TREATED WATER (REUSED AS MAKE-UP WATER)
85
84
86

FIG.5

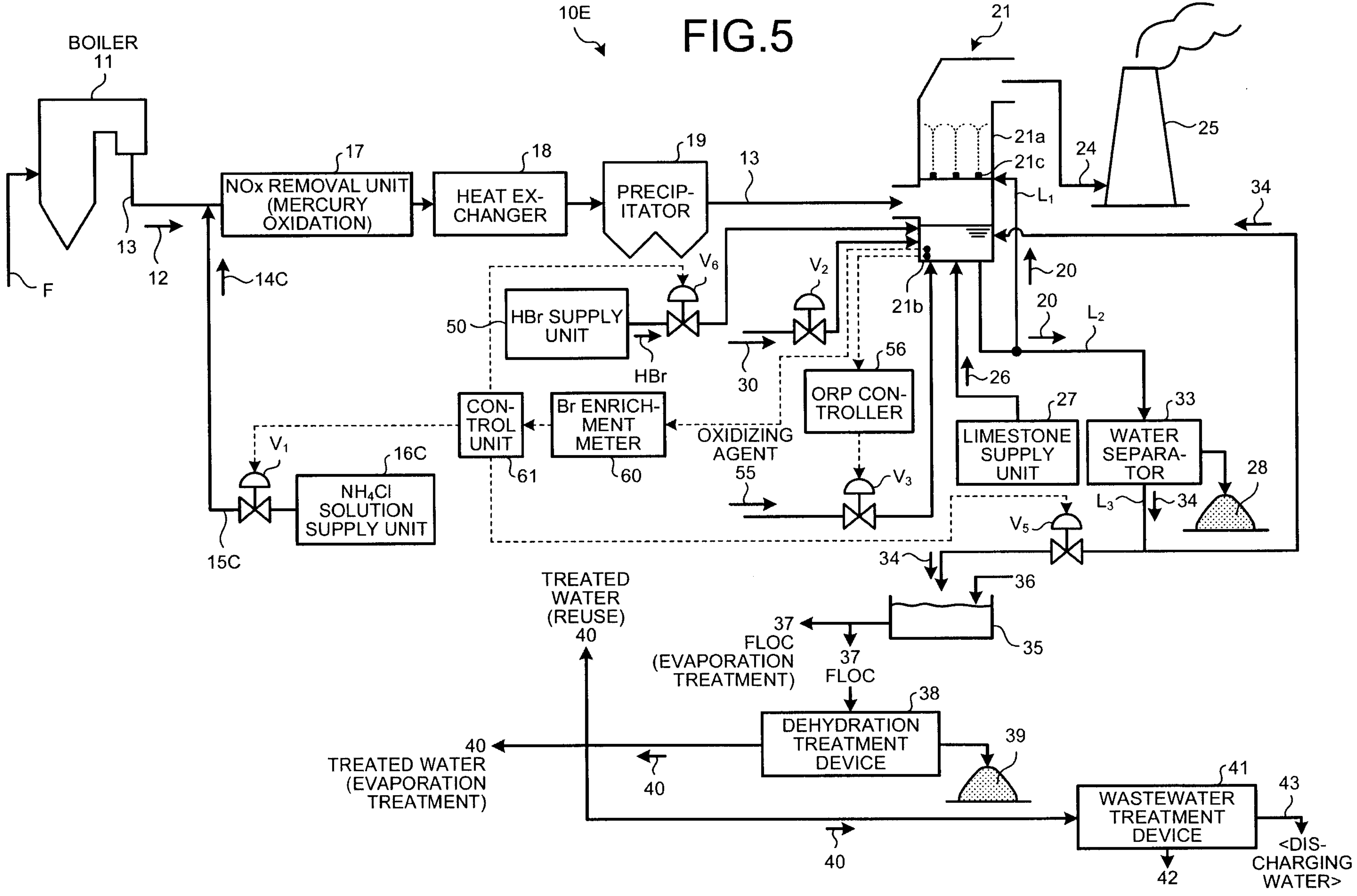

10E
BOILER
11
F
13
12
14C
15C
NOx REMOVAL UNIT (MERCURY OXIDATION)
17
HEAT EX-CHANGER
18
PRECIP-ITATOR
19
13
HBr SUPPLY UNIT
50
HBr
V₆
V₁
NH₄Cl SOLUTION SUPPLY UNIT
16C
CON-TROL UNIT
61
Br ENRICH-MENT METER
60
OXIDIZING AGENT
55
30
V₂
ORP CON-TROLLER
56
V₃
21
21a
21c
21b
L₁
20
20
L₂
26
LIMESTONE SUPPLY UNIT
27
WATER SEPARA-TOR
33
28
L₃
34
34
34
V₅
24
25
36
35
37
FLOC
(EVAPORATION TREATMENT)
37
FLOC
DEHYDRATION TREATMENT DEVICE
38
39
TREATED WATER (REUSE)
40
40
TREATED WATER (EVAPORATION TREATMENT)
40
40
WASTEWATER TREATMENT DEVICE
41
42
43
<DIS-CHARGING WATER>

FIG.6

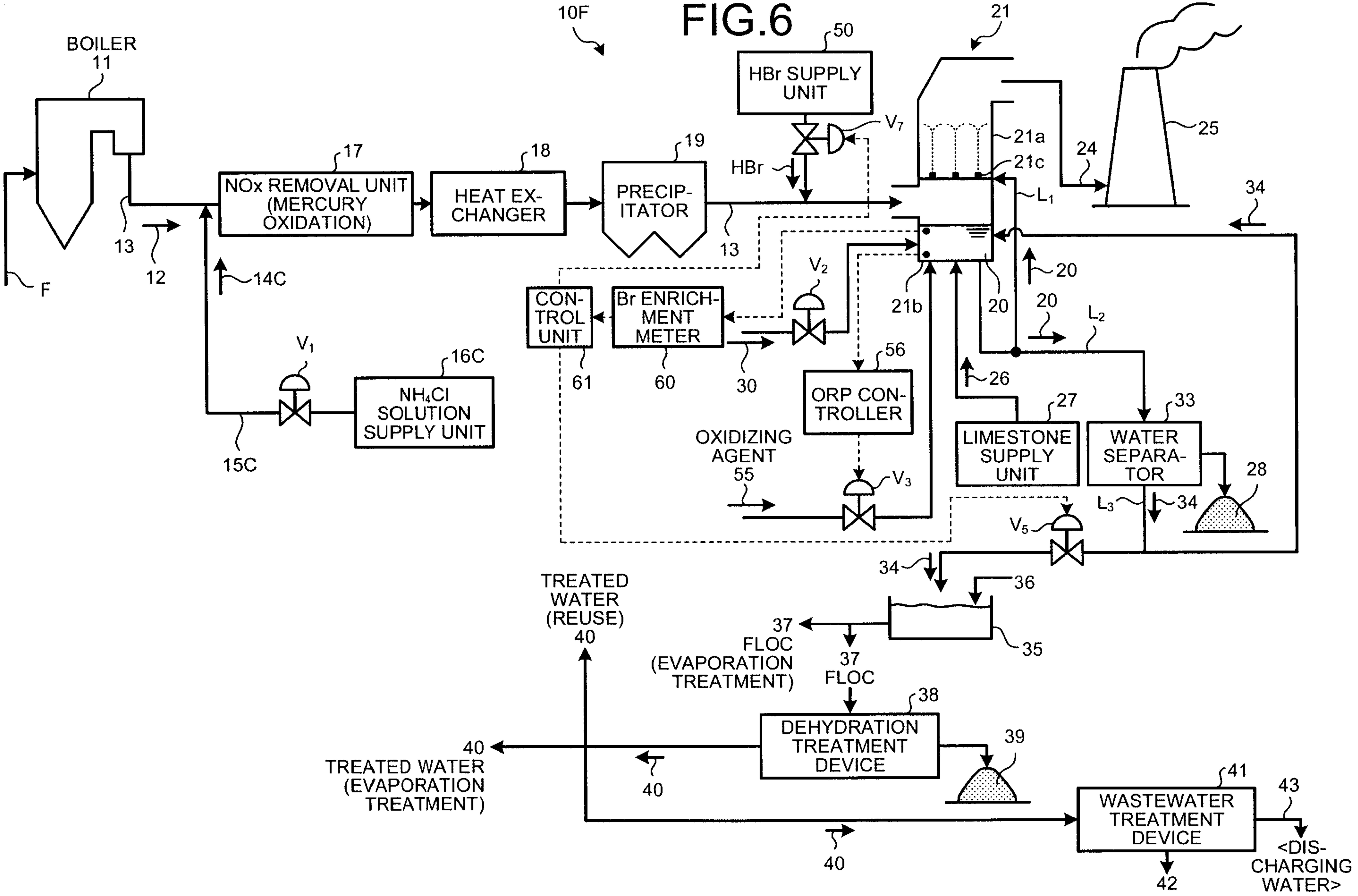
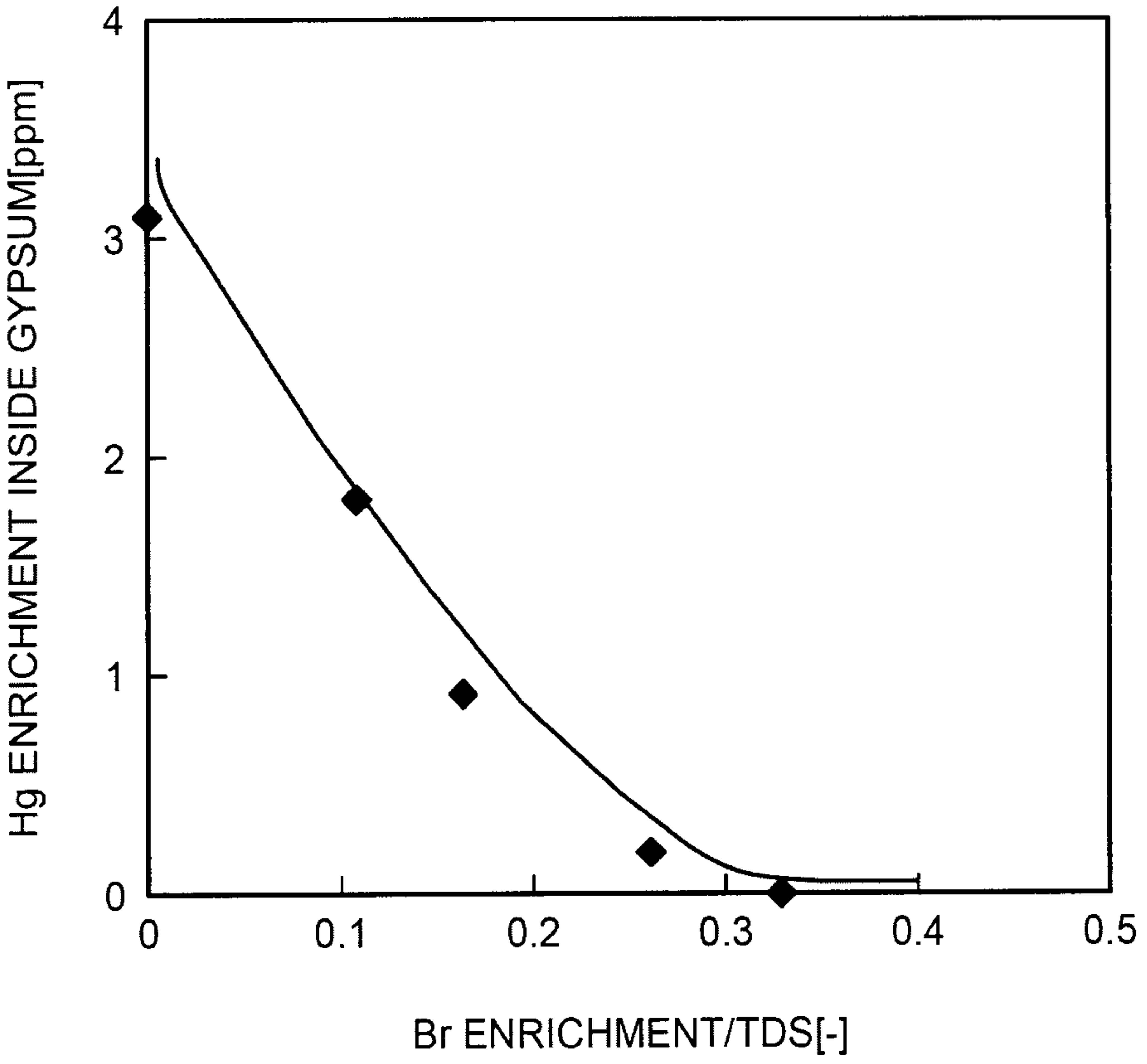
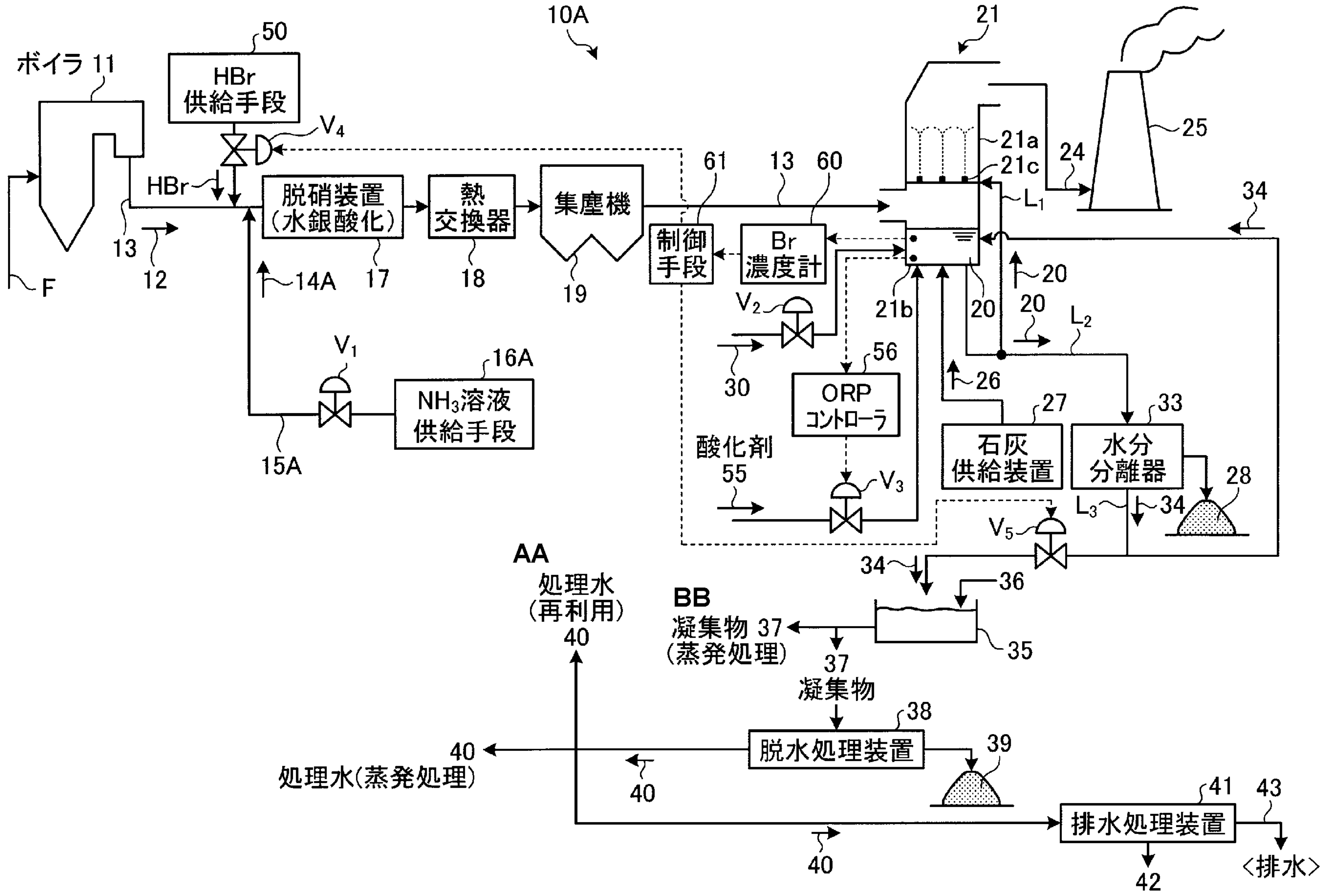

10F
BOILER
11
F
13
12
14C
15C
V1
NH4Cl SOLUTION SUPPLY UNIT
16C
NOx REMOVAL UNIT (MERCURY OXIDATION)
17
HEAT EX-CHANGER
18
PRECIP-ITATOR
19
13
HBr SUPPLY UNIT
50
V7
HBr
21
21a
21c
21b
L1
20
20
20
L2
L3
24
25
34
34
34
CON-TROL UNIT
61
Br ENRICH-MENT METER
60
30
V2
ORP CON-TROLLER
56
OXIDIZING AGENT
55
V3
26
LIMESTONE SUPPLY UNIT
27
WATER SEPARA-TOR
33
28
V5
36
35
37 FLOC (EVAPORATION TREATMENT)
37 FLOC
DEHYDRATION TREATMENT DEVICE
38
39
TREATED WATER (REUSE) 40
40 TREATED WATER (EVAPORATION TREATMENT)
40
40
WASTEWATER TREATMENT DEVICE
41
42
43
<DIS-CHARGING WATER>

FIG.7


Hg ENRICHMENT INSIDE GYPSUM[ppm]
4
3
2
1
0
0
0.1
0.2
0.3
0.4
0.5
Br ENRICHMENT/TDS[-]

[図1]



11	Boiler
16A	NH_3 solution supply means
17	Denitration device (mercury oxide)
18	Heat exchanger
19	Dust collector
27	Lime supply device
33	Moisture separator
37	Agglomerate
38	Dehydration treatment device
40	Treated water (evaporation treatment)
41	Waste water treatment device
43	Waste water
50	HBr supply means
55	Oxidizing agent
56	ORP controller
60	Br concentration meter
61	Control means
AA	Treated water (re-used)
BB	Agglomerate (evaporation treatment)