DESCRIPTION

Title of Invention:

EXHAUST GAS TREATMENT SYSTEM, EXHAUST GAS TREATMENT METHOD, AND METHOD FOR RETROFITTING EXHAUST GAS TREATMENT SYSTEM

Technical Field

[0001]

The present invention relates to an exhaust gas treatment system, an exhaust gas treatment method, and a method for retrofitting an exhaust gas treatment system.

Background of Art

[0002]

Various gases such as perfluorocarbon (PFC) gases are used in the manufacturing processes of devices including semiconductors, liquid crystal displays, LEDs (light emitting diodes), and solar cells. Examples of gases used in semiconductor manufacturing plants include CF_4, SF_6, and CHF_3 used in dry etching processes, and NF_3, C_2F_6, and C_3F_8 used in thin-film formation processes such as CVD (Chemical Vapor Deposition). These processes generate exhaust gases containing these PFC gases, and PFC gases are not only harmful but also act as greenhouse gases.

[0003]

Known equipment for treating exhaust gases containing PFC gases include exhaust gas treatment equipment (abatement systems) that treat exhaust gases by combustion abatement or the like (for example, see Patent Document 1). In addition, wastewater treatment facilities that treat wastewater from exhaust gas treatment facilities and then return the water to the exhaust gas treatment facilities are also known (for example, see Patent Document 2).

Prior Art Documents

Patent Documents

[0004]

Patent Document 1: JP 2022-72981 A

Patent Document 2: JP 2022-70609 A

Summary of the Invention

Problem to be Solved by the Invention

[0005]

In recent years, the amount of gas used in semiconductor manufacturing processes has been increasing due to the miniaturization and multi-layering of semiconductor devices. Consequently, the amount of harmful substances that need to be abated (or decomposed) is also increasing. As a result, the scale of exhaust gas treatment facilities and wastewater treatment facilities is also increasing, along with increases in plant costs and operating expenses.

[0006]

The object of the present invention is to provide an exhaust gas treatment system, an exhaust gas treatment method, and a method for improving an exhaust gas treatment system that can prevent increase in the scale of exhaust gas treatment facilities and/or wastewater treatment facilities and that can prevent increases in plant costs and operating expenses.

Means for Solving the Problem

[0007]

In order to achieve the above object, according to one aspect of the present invention, there is provided an exhaust gas treatment system comprising: an exhaust gas separation section that receives a first gas containing a specific substance, separates a portion of the specific substance contained in the first gas, and discharges a second gas having a lower content of the specific substance than the first gas; a combustion section that treats the second gas to combust the specific substance; a scrubbing section that scrubs the specific substance that has been combusted into feed water to discharge first wastewater; and a wastewater treatment facility that receives the first wastewater, removes the specific substance from the first wastewater, and recovers wastewater from which the specific substance has been removed as make-up water for the feed water.

[0008]

According to another aspect of the present invention, there is provided an exhaust gas treatment method comprising: a step of receiving a first gas containing a specific substance, separating a portion of the specific substance contained in the first gas, and discharging a second gas having a lower content of the specific substance than the first gas; a step of treating the second gas to combust the specific substance; a step of scrubbing the specific substance that

has been combusted into feed water to discharge first wastewater; and a step of receiving the first wastewater, removing the specific substance from the first wastewater, and recovering wastewater from which the specific substance has been removed as make-up water for the feed water.

[0009]

According to yet another aspect of the present invention, there is provided a method for retrofitting an exhaust gas treatment system comprising an abatement system that treats exhaust gas containing a specific substance to combust the specific substance and that scrubs the combusted specific substance into feed water to discharge first wastewater, and a wastewater treatment facility that receives the first wastewater, removes the specific substance from the first wastewater, and recovers wastewater from which the specific substance has been removed as make-up water for the feed water, said method comprising providing an exhaust gas separation device that receives a first gas containing the specific substance, separates a portion of the specific substance contained in the first gas, and discharges a second gas having a lower content of the specific substance than the first gas.

Advantageous Effects of the Invention

[0010]

According to the present invention, the large-scale expansion of an exhaust gas treatment facility and/or wastewater treatment facility can be prevented, and in addition, increases in plant costs and operating costs can be prevented.

Brief Description of the Drawings

[0011]

[FIG. 1] FIG. 1 is a schematic diagram showing an exhaust gas treatment system according to a first embodiment of the present invention.

[FIG. 2] FIG. 2 is a schematic diagram showing an example of an abatement system in the exhaust gas treatment system shown in FIG. 1.

[FIG. 3] FIG. 3 is a schematic diagram showing an example of a wastewater treatment facility in the exhaust gas treatment system shown in FIG. 1.

[FIG. 4] FIG. 4 is a schematic diagram showing an exhaust gas treatment system of a comparative example.

[FIG. 5] FIG. 5 is a schematic diagram showing an exhaust gas treatment system

according to a second embodiment of the present invention.
[FIG. 6] FIG. 6 is a schematic diagram showing an example of a fluorine-based discharge device in the exhaust gas treatment system shown in FIG. 5.
[FIG. 7] FIG. 7 is a schematic diagram showing an example of a total discharge wastewater device in the exhaust gas treatment system shown in FIG. 5.
[FIG. 8] FIG. 8 is a schematic diagram showing an exhaust gas treatment system of a comparative example.
[FIG. 9] FIG. 9 is a schematic diagram for explaining the connection configurations between an abatement system and a gas treatment device.
[FIG. 10] FIG. 10 is a schematic diagram showing examples of the arrangement of an exhaust gas separation device.
[FIG. 11] FIG. 11 is a schematic diagram showing other examples of the arrangement of an exhaust gas separation device.
[FIG. 12] FIG. 12 is a schematic diagram showing yet another example of the arrangement of an exhaust gas separation device.
[FIG. 13] FIG. 13 is a schematic diagram showing yet another example of the arrangement of an exhaust gas separation device.

Description of the Embodiments

[0012]

Embodiments of the present invention will next be described in detail with reference to the drawings. Constituent elements described in the embodiments are merely examples and are not intended to limit the scope of the present invention.

First Embodiment

[0013]

FIG. 1 is a schematic diagram showing the configuration of an exhaust gas treatment system according to the first embodiment of the present invention. In FIG. 1, the solid-line arrows schematically represent piping. Referring to FIG. 1, exhaust gas treatment system 10 has exhaust gas separation device (exhaust gas separation section) 11, abatement system (exhaust gas treatment facility) 12, and wastewater treatment facility 13.

[0014]

In this embodiment, exhaust gas separation device 11 and abatement system 12 are installed in fab 20. Fab 20 is equipped with multiple process tools

21 that discharge first gas 22a containing a specific substance. Abatement system 12 is connected to at least one of process tools 21 via exhaust gas separation device 11. In this embodiment, abatement system 12 is connected via exhaust gas separation device 11 to process tool 21 that performs a thin-film formation process and process tool 21 that performs a dry etching process. The thin-film formation process may include but is not limited to a CVD process.

[0015]

In the dry etching process, PFC gases such as CF_4, SF_6, and CHF_3 are used, while in the thin-film formation process, PFC gases such as NF_3, C_2F_6, and C_3F_8 and semiconductor material gases such as SiH_4, NH_3, SiH_2Cl_2, and TEOS (tetraethoxysilane) are used. Gases such as NF_3 and Cl_2 are also used to clean the inside of the process tools. Process tool 21 discharges first gas 22a containing these gases. Gases that are not used in the reaction are discharged together with the gases that are used and decomposed in the reaction (such as HF, CO_2, and decomposition gases). In each process tool 21, first gas 22a is discharged by using, for example, a vacuum pump. In this case, a large amount of nitrogen (N_2) gas may be introduced for the purpose of protecting equipment downstream of the vacuum pump as well as for safety reasons. Here, first gas 22a contains a specific substance. The specific substance may include fluorine (F) and/or a fluorine compound. The specific substance may also include nitrogen (N) and/or a nitrogen compound. Note that the specific substance is not limited to fluorine and a fluorine compound or nitrogen and a nitrogen compound. For example, the specific substance may include other components such as a carbon source (C), chlorine (Cl), silicon (Si), and compounds of these elements. In other words, the specific substance may include at least one component selected from fluorine, nitrogen, carbon, silicon, and/or compounds of these components.

[0016]

Exhaust gas separation device 11 receives first gas 22a discharged from both process tool (film formation device) 21 and process tool (dry etching) 21. First gas 22a may contain decomposition products and/or by-products of the gas discharged from process tools 21. Exhaust gas separation device 11 separates a portion of the specific substance contained in first gas 22a and discharges second gas 22b having a lower content of the specific substance than first gas 22a. In this embodiment, the specific substance is assumed to be fluorine and/or compounds thereof. Exhaust gas separation device 11 separates and recovers a portion of the fluorine contained in first gas 22a. In this case, for example, exhaust

gas separation device 11 may recover fluorine as a valuable resource.

[0017]

Exhaust gas separation device 11 may have any configuration capable of recovering a specific substance (here, fluorine) from first gas 22a. Common gas recovery technologies include cryogenic distillation in which substances are separated based on differences in boiling points, pressure swing adsorption (PSA) and temperature swing adsorption (TSA) that involve repeated adsorption and desorption, and membrane separation that employs gas separation membranes. Any one or a combination of these gas recovery technologies may be applied in exhaust gas separation device 11.

[0018]

When a specific substance is separated and recovered in exhaust gas separation device 11, recovery rate R1 of the specific substance can be set to a theoretically or practically possible value depending on the recovery method and the substance to be recovered. For example, in this embodiment, the specific substance is fluorine, and exhaust gas separation device 11 is configured such that fluorine recovery rate R1 is 50%. Here, fluorine recovery rate R1 indicates the recovery rate relative to the total fluorine load when first gas 22a is a mixed gas of, for example, NF_3, CF_4, and SF_6.

[0019]

Abatement system 12 receives feed water that contains make-up water 24 from wastewater treatment facility 13 and second gas 22b discharged by exhaust gas separation device 11. Abatement system 12 abates harmful substances including specific substances by burning second gas 22b and discharges wastewater in which components derived from the decomposed harmful substances are scrubbed in the feed water. Because fluorine is here assumed to be the specific substance, abatement system 12 discharges first wastewater 23a in which fluorine is scrubbed in the feed water.

[0020]

The configuration of abatement system 12 is next explained in detail. FIG. 2 is a schematic diagram showing an example of the configuration of abatement system 12. In FIG. 2, solid arrows schematically show piping through which liquids flow, and dashed arrows schematically show piping through which gases flow. Referring to FIG. 2, abatement system 12 has combustion (solubilization) section 121 and scrubbing (dissolution) section 122. Combustion section 121 treats second gas 22b to combust a specific substance. Scrubbing section 122

scrubs the specific substance combusted in combustion section 121 into feed water and discharges first wastewater 23a. Feed water 25 may contain make-up water 24.

[0021]

Combustion section 121 may include, for example, a combustion chamber in which a combustion treatment is carried out using a burner. Second gas 22b is supplied to the combustion chamber and decomposed by a thermal decomposition reaction (combustion of a specific substance). In this case, the combustion chamber may be cooled with feed water 25 containing make-up water 24. The water used for cooling is discharged as first wastewater 23a.

Scrubbing section 122 may include, for example, a scrubber that sprinkles water into a gas. The gas in the combustion chamber of combustion section 121 is supplied to the scrubber. Within the scrubber, specific substances remaining in the gas are scrubbed in water due to the sprinkled water (scrubbing). The water in which the specific substances are scrubbed is discharged from the bottom of the scrubber as first wastewater 23a.

[0022]

Combustion section 121 and scrubbing section 122 may be the same device. Furthermore, the combination of the combustion chamber that constitutes combustion section 121 and the scrubber that constitutes scrubbing section 122 is not limited to the configuration described above. For example, a scrubber may be provided on each of the inlet and outlet sides of the combustion chamber. Furthermore, a smoke-cleaning chamber that sprinkles water on the gas may be provided between the combustion chamber and the scrubber.

Additionally, for example, an existing abatement system that uses electric heating or plasma to abate specific substances may be used as abatement system 12. A detailed description of such an abatement system will be omitted, but a device with a commonly used configuration can be employed.

[0023]

Wastewater treatment facility 13 receives first wastewater 23a discharged by abatement system 12. Wastewater treatment facility 13 removes specific substances (here, fluorine) from first wastewater 23a and supplies the wastewater from which the specific substances have been removed to abatement system 12 as make-up water 24 for feed water 25. Wastewater treatment facility 13 further discharges second wastewater 23b containing the removed specific substances.

[0024]

FIG. 3 shows an example of wastewater treatment facility 13. As shown in FIG. 3, wastewater treatment facility 13 has raw water tank 130, heat exchanger 131, neutralization tank 132, biological reaction tank (biological treatment) 133, intermediate tank 134, ultrafiltration device (UF) 135, intermediate tank 136, reverse osmosis membrane filtration device (RO) 137, and make-up water tank 138.

First wastewater 23a discharged from abatement system 12 is stored in raw water tank 130 as water to be treated. Raw water tank 130 and heat exchanger 131 are connected via piping, and pump 139a is provided in this piping. Heat exchanger 131 and neutralization tank 132 are connected via piping. Neutralization tank 132 and biological reaction tank 133 are connected via piping. Biological reaction tank 133 and intermediate tank 134 are connected via piping. Intermediate tank 134 and UF 135 are connected via piping. UF 135 and intermediate tank 136 are connected via piping. intermediate tank 136 and RO 137 are connected via piping, and pump 139b is provided in this piping. RO 137 and make-up water tank 138 are connected via piping. Discharge piping is connected to make-up water tank 138, and pump 139c is provided in this piping. By controlling pumps 139a to 139c, the water to be treated that is stored in raw water tank 130 can be supplied sequentially at appropriate times to heat exchanger 131, neutralization tank 132, biological reaction tank 133, intermediate tank 134, UF (ultrafiltration membrane device) 135, intermediate tank 136, RO (reverse osmosis membrane device) 137, and make-up water tank 138.

[0025]

Heat exchanger 131 performs a heat exchange treatment using cooling water. Neutralization tank 132 performs a neutralization treatment using a neutralizing agent. The neutralized water to be treated is supplied to biological reaction tank 133 after nutrients have been added. Biological reaction tank 133 performs a biological treatment. Biological reaction tank 133 is equipped with a mechanism for aerating the water being treated (an air bubbling mechanism for supplying the oxygen necessary for microorganisms). The biologically treated water is supplied to UF 135 via intermediate tank 134. UF 135 filters the biologically treated water using multiple UF membranes having fine pores. The filtered water from UF 135 is stored in intermediate tank 136, and a dispersant and slime control agent are then added to the filtered water before the water is supplied to RO 137. RO 137 further filters the filtered water from UF 135 using

multiple RO membranes. The filtered water (permeated water) from RO 137 is stored in make-up water tank 138. The water stored in make-up water tank 138 is mixed with NaClO and is then discharged as make-up water 24 and supplied to abatement system 12. Concentrate water separated in UF 135 and RO 137 is discharged as second wastewater 23b.

[0026]

According to exhaust gas treatment system 10 of the present embodiment described above, the cooling energy required for abatement system 12 can be reduced by separating a part of the specific substance (a component such as fluorine) contained in first gas 22a by exhaust gas separation device 11. As a result, abatement system 12 and wastewater treatment facility 13 can be prevented from becoming large-scale, and increases in plant costs and operating costs can be prevented. This effect is next explained in detail with a comparative example.

Comparative Example 1

[0027]

FIG. 4 is a schematic diagram showing the exhaust gas treatment system of Comparative Example 1. Exhaust gas treatment system 100 of Comparative Example 1 differs from exhaust gas treatment system 10 of the present embodiment in that it does not include exhaust gas separation device 11. Other than exhaust gas separation device 11, the configuration of exhaust gas treatment system 100 is basically the same as that of exhaust gas treatment system 10.

In exhaust gas treatment system 100, first gas 22a discharged from each process tool 21 is supplied directly to abatement system 12. Therefore, the amount of harmful substances to be abated (or decomposed) increases compared to a configuration that includes exhaust gas separation device 11. Consequently, the heat generated by abatement system 12 increases, and the amount of feed water 25 required for cooling also increases. As a result, the amount of first wastewater 23a from abatement system 12 increases, the scale of the drainage and recovery facilities increases, and the plant and operating costs also increase.

[0028]

The above problems are specifically explained assuming fluorine (F) as a specific substance contained in the exhaust gas. In exhaust gas treatment

system 100, the amount of fluorine in first gas 22a supplied to abatement system 12 per day is assumed to be, for example, 2,000 kg/d. The thermal energy required to treat 2,000 kg/d of fluorine is consumed in abatement system 12, and an amount of feed water 25 that corresponds to the amount of heat generated is used. The amount of first wastewater 23a discharged per day from abatement system 12 is assumed to be 20,000 m^3/d. The amount of fluorine contained in first wastewater 23a per day is 2,000 kg/d. Note that first wastewater 23a also contains components other than fluorine. The F concentration in second wastewater 23b is, for example, 2,000 mg/L.

[0029]

In contrast, in exhaust gas treatment system 10 of the present embodiment, exhaust gas separation device 11 recovers a portion of the fluorine contained in first gas 22a. Because fluorine recovery rate R1 is here 50%, the amount of fluorine in first gas 22a per day is assumed to be 2,000 kg/d. In this case, the amount of fluorine in second gas 22b supplied to abatement system 12 per day is 1,000 kg/d. The thermal energy required to treat 1,000 kg/d of fluorine is consumed in abatement system 12, and an amount of feed water 25 is used that corresponds to the amount of heat generated. The amount of this feed water 25 can be reduced compared to Comparative Example 1. Specifically, the amount of first wastewater 23a discharged per day from abatement system 12 can be reduced to 15,000 m^3/d, compared to 20,000 m^3/d in Comparative Example 1.

[0030]

As described above, according to exhaust gas treatment system 10 of the present embodiment, the amount of first wastewater 23a discharged from abatement system 12 and the amount of fluorine contained in first wastewater 23a can be reduced compared to Comparative Example 1. This reduction allows a reduction of the scale of abatement system 12 and wastewater treatment facility 13 and a consequent reduction of plant costs and operating expenses. Here, reducing plant costs includes a reduction of the construction costs of plant facilities as well as a reduction of the installation space due to scale reduction. The operating costs also include the energy costs related to operation, the costs of chemicals such as neutralizing agents required to recover specific decomposed substances (components such as fluorine), and the costs of treating waste such as sludge. Reducing operating costs includes reducing the amounts of input chemicals and reducing energy costs (power consumption).

[0031]

Furthermore, increase in the amount of harmful substances to be abated (or decomposed) along with increase in the amount of exhaust gas increases the energy consumption and heat generation of the abatement system, and further, increases the amount of make-up water required for cooling and for scrubbing components derived from the harmful substances. As a result, the amount of wastewater and the load upon the abatement system increase, the scale of the wastewater treatment facility increases, and plant costs and operating costs increase. Exhaust gas treatment system 10 of the present embodiment enables a reduction of the amount of first wastewater 23a discharged from abatement system 12 and the amount of fluorine contained in first wastewater 23a. As a result, increase in the energy consumption and heat generation of abatement system 12 can be prevented even though the amount of harmful substances to be abated (or decomposed) increases along with increase in the amount of exhaust gas, and the increase in the amount of make-up water required for cooling and for scrubbing components derived from the harmful substances can be prevented. As a result, the increase in the amount of wastewater and load upon abatement system 12 and the increase in the scale of wastewater treatment facility 13 can be prevented, and increase in plant costs and operating costs can be prevented.

[0032]

Specifically, fuel for the burner in combustion section 121 and energy such as electricity in abatement system 12 shown in FIG. 2 can be reduced by reducing the amount of supply of second gas 22b and the amount of load. Reducing the amount of supply (required amount) of feed water 25 enables a reduction of the scale/capacity of the supply equipment such as piping as well as the feed water pump for supplying feed water 25 to scrubbing section 122. Reducing the flow rate of second gas 22b enables a reduction of the scale of combustion section 121 and auxiliary equipment thereof, a reduction of the scale of scrubbing section 122 and auxiliary equipment thereof, and a reduction of the scale of the supply equipment such as piping and the water supply pump for discharging first wastewater 23a.

[0033]

In wastewater treatment facility 13 shown in FIG. 3, reducing the amount of first wastewater 23a enables a reduction of the scale of each of raw water tank 130, heat exchanger 131, neutralization tank 132, biological reaction tank 133, intermediate tank 134, UF 135, intermediate tank 136, RO 137, and make-up

water tank 138, as well as a reduction of the scale of the piping connecting these components. For example, if the volume of neutralization tank 132 is 209 m^3 and the volume of biological reaction tank 133 is 834 m^3 in Comparative Example 1, the volume of neutralization tank 132 in exhaust gas treatment system 10 of the present embodiment can be reduced to 157 m^3 and the volume of biological reaction tank 133 can be reduced to 625 m^3.

In addition, reducing the amount of first wastewater 23a enables a reduction of the amounts (required amounts) of cooling water, neutralizing agent, nutrients, dispersants, slime control agent, and NaClO. Furthermore, reducing the load of TOC (total organic carbon) that is a component contained in first wastewater 23a enables a scaling down of biological reaction tank 133.

[0034]

Furthermore, reducing the load of silica (silicic acid) and solids that are components contained in first wastewater 23a enables a reduction of the number of UF membranes, and a scaling down of UF 135. For example, if UF 135 in Comparative Example 1 is equipped with 223 UF membranes, the number of UF membranes in UF 135 can be reduced to 150 in exhaust gas treatment system 10 of this embodiment.

Furthermore, reducing the load of components (ions) in second wastewater 23b enables a reduction of the number of RO membranes and a scaling down of RO137. For example, if RO 137 in Comparative Example 1 is equipped with 1,012 RO membranes, the number of RO membranes in RO 137 can be reduced to 655 in exhaust gas treatment system 10 of this embodiment.

[0035]

Furthermore, according to exhaust gas treatment system 10 of this embodiment, water recovery rate R2 of wastewater treatment facility 13 can be improved compared to Comparative Example 1. For example, CaF_2 scale on the RO membrane concentration side may be the rate-determining factor regarding water recovery rate R2 of wastewater treatment facility 13. Setting the concentration of fluoride on the concentrate side of the RO membrane to the same value of 2000 mg/L in both Comparative Example 1 and the present embodiment results in water recovery rate R2 of 97% in the present embodiment as compared with 95% in Comparative Example 1.

Note that rater recovery rate R2 of wastewater treatment facility 13 varies depending on fluorine recovery rate R1 of exhaust gas separation device 11. Specifically, when the amount of wastewater from abatement system 12 is

constant (when the amount of feed water to wastewater treatment facility 13 is constant), the water recovery rate R2 can be increased as fluorine recovery rate R1 increases. For example, when fluorine recovery rate R1 is 70%, water recovery rate R2 of 98% can be achieved.

Table 1 shows the results of comparison between the present embodiment (fluorine recovery rate R1: 50% / 70%) and Comparative Example 1.

Table 1

	Present embodiment (fluorine recovery rate R1:50%)	Present embodiment (fluorine recovery rate R1:70%)	Comparative example 1
Amount of first gas 22a	2，000kg／d	2，000kg／d	2，000kg／d
Recovery amount of detoxified gas	1，000kg／d	1，400kg／d	0kg／d
Amount of second gas 22b	1，000kg／d	600kg／d	2，000kg／d
Amount of feed water to detoxification device 12	15，000m^3／d	15，000m^3／d	20，000m^3／d
Detoxification recovery device 13_ volume of neutralization tank	157m^3	157m^3	209m^3
Detoxification recovery device 13_ volume of biological reaction tank	625m^3	625m^3	834m^3
Detoxification recovery device 13_ number of UF membranes	150	150	223
Detoxification recovery device 13_ number of RO membranes	665	665	1012
Detoxification recovery device 13_ water recovery rate	97%	98%	95%

Second Embodiment

[0036]

Fig. 5 is a schematic diagram showing the configuration of an exhaust gas treatment system according to the second embodiment of the present invention. Exhaust gas treatment system 10A of this embodiment differs from the first embodiment in that it includes water treatment device 16. Since exhaust gas separation device 11, abatement system 12, and wastewater treatment facility 13 are the same as in the first embodiment, detailed explanations of their configurations will here be omitted.

[0037]

Water treatment device 16 receives second wastewater 23b discharged from wastewater treatment facility 13 and performs a water treatment to remove a specific substance from second wastewater 23b. In this embodiment, fluorine is assumed to be the specific substance, and water treatment device 16 has a fluorine-based wastewater device 14 and total discharge wastewater device 15.

[0038]

Fluorine-based wastewater device 14 receives second wastewater 23b and flocculates and precipitates the fluorine contained in second wastewater 23b. FIG. 6 shows the specific configuration of fluorine-based wastewater system 14.

As shown in FIG. 6, fluorine-based wastewater device 14 has reaction tanks 140 and 141, flocculation tank 142, precipitation tank 143, and dehydrator 144. Reaction tank 140 and reaction tank 141 are connected via piping. Reaction tank 141 and flocculation tank 142 are connected via piping. Flocculation tank 142 and precipitation tank 143 are connected via piping. Precipitation tank 143 and dehydrator 144 are connected via piping.

Second wastewater 23b discharged from wastewater treatment facility 13 is stored in reaction tank 140. In reaction tank 140, $Ca(OH)_2$ (calcium hydroxide) is added as a neutralizing agent. The water to be treated to which calcium hydroxide has been added is stored in reaction tank 141. In reaction tank 141, PAC (polyaluminum chloride) and NaOH (sodium hydroxide) are added. PAC is a flocculant that flocculates suspended solids contained in the water being treated and facilitates precipitation. NaOH is an alkaline agent that adjusts the pH of the water to be treated.

[0039]

The water stored in reaction tank 141 is supplied to precipitation tank 143 via flocculation tank 142. In flocculation tank 142, the suspended solids contained in the water being treated are flocculated and precipitated as flocculates (flocs) that are minute aggregates. The flocculates (flocs) precipitate in precipitation tank 143. The precipitates are supplied to dehydrator 144, and the water being treated from which the precipitates have been removed is supplied as wastewater to total discharge wastewater system 15. In dehydrator 144, the precipitates are dehydrated and discharged as sludge.

Although a flocculation and precipitation method that uses calcium hydroxide has been described above, a crystallization reaction apparatus may also be used for obtaining calcium fluoride crystals as disclosed in Japanese Patent No. 5650164. Fluorine-based wastewater device 14 is not limited to these methods.

[0040]

Total discharge wastewater device 15 receives the wastewater discharged from fluorine-based wastewater device 14 and performs a neutralization treatment. FIG. 7 shows the specific configuration of total discharge wastewater device 15. As shown in FIG. 7, total discharge wastewater device 15 includes reaction tank 150, flocculation tank 151, and flotation tank 152. Reaction tank 150 and flocculation tank 151 are connected via piping. Flocculation tank 151 and flotation tank 152 are connected via piping.

The wastewater discharged from precipitation tank 143 of fluorine-based wastewater device 14 is stored in reaction tank 150. PAC and NaOH are added to reaction tank 150. The water stored in reaction tank 150 is supplied to flotation tank 152 via flocculation tank 151. In flocculation tank 151, the suspended solids contained in the water being treated coagulate and flocs are precipitated. Flotation tank 152 is a solid-liquid separation tank. In flotation tank 152, pressurized water in which gas is scrubbed under pressure is injected from the bottom of the tank. The attachment of air bubbles to the flocs gives the flocs buoyancy and the flocs float up and separate. The clean water at the bottom of the water stored in flotation tank 152 is discharged as flotation-treated water. The flotation-treated water can be discharged into rivers or into the ocean, for example, or can be reused as recovered water.

[0041]

According to exhaust gas treatment system 10A of the present embodiment described above, exhaust gas separation device 11 recovers a portion of the specific substance contained in first gas 22a, thereby simultaneously achieving a reduction of the cooling energy required for abatement system 12 and a reduction of the treatment load of the specific substance (here, fluorine) in water treatment device 16. As a result, in addition to the effects described in the first embodiment, the equipment for water treatment device 16 can be scaled down, and plant costs and operating costs can be reduced. In addition, the amount of sludge generated by the fluorine flocculation and the precipitation treatment can be reduced. These effects will be specifically explained below using a comparative example.

Comparative Example 2

[0042]

FIG. 8 is a schematic diagram showing the exhaust gas treatment system of Comparative Example 2. Exhaust gas treatment system 100A of Comparative Example 2 differs from exhaust gas treatment system 10A of the present embodiment in that it does not include exhaust gas separation device 11. In exhaust gas treatment system 100A, the configuration other than exhaust gas separation device 11 is basically the same as that of exhaust gas treatment system 10A.

[0043]

In exhaust gas treatment system 100A, the amount of second wastewater

23b discharged from wastewater treatment facility 13 per day is assumed to be, for example, 1,000 m^3/d. The amount of fluorine contained in second wastewater 23b per day is 2,000 kg/d. Fluorine-based wastewater device 14 performs flocculation and precipitation treatment of 2,000 kg/d of fluorine and removes the fluorine as 8.4 tons of sludge material. The amount of wastewater discharged from fluorine-based wastewater device 14 per day is assumed to be 880 m^3/d. The amount of wastewater treated by total discharge wastewater device 15 is assumed to be 880 m^3/d.

[0044]

According to exhaust gas treatment system 10A of the present embodiment, the amount of second wastewater 23b discharged from wastewater treatment facility 13 per day can be reduced from 1,000 m^3/d in Comparative Example 2 to 500 m^3/d. Furthermore, the amount of fluorine contained in second wastewater 23b per day can be reduced from 2,000 kg/d in Comparative Example 2 to 1,000 kg/d. As a result, fluorine-based wastewater device 14 performs flocculation and precipitation treatment of 1,000 kg/d of fluorine and thus the amount of sludge is reduced from 8.4 tons in Comparative Example 2 to 4.2 tons. Furthermore, the amount of wastewater discharged from fluorine-based wastewater device 14 per day can be reduced from 880 m^3/d in Comparative Example 2 to 440 m^3/d. As a result, the amount of wastewater treated by total discharge wastewater device 15 can be reduced from 880 m^3/d in Comparative Example 2 to 440 m^3/d.

[0045]

As described above, according to the exhaust gas treatment system 10A of the present embodiment, the amount of fluorine treated by fluorine-based wastewater device 14 can be reduced by half compared to Comparative Example 2. The scale of the equipment of fluorine-based wastewater device 14 can thus be reduced, and the input amount of chemical agent required for the flocculation and precipitation treatment can be reduced.

[0046]

Specifically, in fluorine-based wastewater device 14 shown in FIG. 6, reducing the amount of water and the amount of fluorine in second wastewater 23b enables a reduction of the scale of each of reaction tanks 140 and 141, flocculation tank 142, precipitation tank 143, and dehydrator 144 as well as a reduction of the scale of the piping connecting these components. For example, in Comparative Example 2, the volume of reaction tank 140 is assumed to be 11

m^3, the volume of reaction tank 141 is assumed to be 11 m^3, the volume of flocculation tank 142 is assumed to be 4 m^3, the area of precipitation tank 143 is assumed to be 4 m^2, and the membrane area of dehydrator 144 is assumed to be 56 m^2. In exhaust gas treatment system 10A of the present embodiment, the volume of reaction tank 140 can be reduced to 6 m^3, the volume of reaction tank 141 can be reduced to 6 m^3, the volume of flocculation tank 142 can be reduced to 2 m^3, the area of precipitation tank 143 can be reduced to 2 m^2, and the membrane area of dehydrator 144 can be reduced to 28 m^2. Downsizing these facilities enable a reduction of plant costs by approximately 50%.

[0047]

Furthermore, in Comparative Example 2, the input amount of $Ca(OH)_2$ is assumed to be 4,200 kg/d, the input amount of PAC is assumed to be 300 kg/d, and the input amount of NaOH (caustic soda) is assumed to be 163 kg/d. In exhaust gas treatment system 10A of the present embodiment, the input amount of $Ca(OH)_2$ can be reduced to 2,100 kg/d, the input amount of PAC can be reduced to 151 kg/d, and the input amount of NaOH can be reduced to 82 kg/d.

In total discharge wastewater device 15 shown in FIG. 7, reducing the amount of water and the amount of fluorine in second wastewater 23b enables a reduction of the scale of each of reaction tank 150, flocculation tank 151, and flotation tank 152 as well as a reduction of the scale of piping connecting these components. For example, in Comparative Example 2, the volume of reaction tank 150 is assumed to be 10 m^3, the volume of flocculation tank 151 is assumed to be 4 m^3, and the area of flotation tank 152 is assumed to be 2 m^2. In exhaust gas treatment system 10A of the present embodiment, the volume of reaction tank 150 can be reduced to 5 m^3, the volume of flocculation tank 151 can be reduced to 2 m^3, and the area of flotation tank 152 can be reduced to 1 m^2. Downsizing these facilities enables a reduction of plant costs by approximately 50%.

Furthermore, in Comparative Example 2, the input amount of PAC is assumed to be 264 kg/d and the input amount of NaOH is assumed to be 143 kg/d. In exhaust gas treatment system 10A of the present embodiment, the input amount of PAC can be reduced to 133 kg/d and the input amount of NaOH can be reduced to 72 kg/d.

[0048]

Table 2 shows the results of comparison of the present embodiment and Comparative Example 2.

Table 2

	Present embodiment	Comparative example 2
Amount of second wastewater 23b	500 m^3／d	1，000 m^3／d
Fluoride load of detoxification recovery device	1，000 kg／d	2，000 kg／d
Sludge discharge volume	4．2t	8．4 t
Amount of total wastewater	440 m^3／d	880 m^3／d
F-based wastewater_volume of reaction tank 140	6 m^3	11 m^3
F-based wastewater_volume of reaction tank 141	6 m^3	11 m^3
F-based wastewater_volume of flocculation tank 142	2 m^3	4 m^3
F-based wastewater_area of precipitation tank 143	2 m^2	4 m^2
F-based wastewater_membrane area of dehydrator 144	28m^2	56m^2
F-based wastewater_amount of calcium hydroxide added	2，100 kg／d	4，200 kg／d
F-based wastewater_amount of PAC added	151 kg／d	300 kg／d
F-based wastewater_amount of caustic soda added	82 kg／d	163 kg／d
Total drainage system wastewater_volume of reaction tank 150	5 m^3	10 m^3
Total drainage system wastewater_volume of flocculation tank 151	2 m^3	4 m^3
Total drainage system wastewater_area of flotation tank 152	1 m^2	2 m^2
Total drainage system wastewater_amount of PAC added	133 kg／d	264 kg／d
Total drainage system wastewater_amount of caustic soda added	72 kg／d	143 kg／d

[0049]

The first and second embodiments described above are examples of the present invention, and each component of exhaust gas treatment system 10 (10A) can be modified as appropriate within a scope that does not interfere with the effects described in each embodiment.

In the first and second embodiments described above, abatement system 12 and process tool 21 may be arranged in any one of several connection configurations including one-to-one, one-to-many, many-to-one, or many-to-many, or may be arranged in a combination of two or more connection configurations. Exhaust gas separation device 11 may be combined with at least one process tool 21.

[0050]

FIG. 9 is a schematic diagram for explaining the connection configurations between abatement system 12 and process tool 21. In FIG. 9, solid arrows schematically show piping through which gas passes, and one solid line may represent a single pipe or multiple pipes.

As shown in FIG. 9(a), abatement systems 12 and process tools (film formation devices) 21 are arranged in a many-to-many connection configuration, and abatement systems 12 and process tools (dry etching) 21 are also arranged

in a many-to-many connection configuration. In the many-to-many connection configuration in which abatement systems 12 and process tools (film formation devices) 21 are arranged, exhaust gas separation device 11 may be provided anywhere in the communication piping connecting abatement systems 12 and process tools (film formation devices) 21. For example, exhaust gas separation device 11 may be provided for each process tool (film formation device) 21 or each abatement system 12, or may be provided at a collection part where two or more process tools (film formation devices) 21 are connected or at a collection part where two or more abatement systems 12 are connected. Similarly, in the many-to-many connection configuration in which abatement systems 12 and process tools (dry etching) 21 are arranged, exhaust gas separation device 11 may be provided anywhere in the communication piping connecting between abatement systems 12 and process tools (dry etching) 21. For example, exhaust gas separation device 11 may be provided for each process tool (dry etching) 21, or may be provided at a collection part where two or more process tools (dry etching) 21 are connected.

[0051]

As shown in FIG. 9 (b), abatement system 12 and process tool (film formation device) 21 are arranged in a one-to-one connection configuration, and abatement system 12 and process tool (dry etching) 21 are arranged in a one-to-one connection configuration. In this case, exhaust gas separation device 11 may be provided for at least one process tool (film formation device) 21. Similarly, exhaust gas separation device 11 may be provided for at least one process tool (dry etching) 21.

[0052]

As shown in FIG. 9(c), abatement systems 12 and process tool (film formation device) 21 are arranged in a many-to-one connection configuration, and abatement systems 12 and process tool (dry etching) 21 are also arranged in a many-to-one connection configuration. In the many-to-one connection configuration in which abatement systems 12 and process tool (film formation device) 21 are arranged, exhaust gas separation device 11 may be provided anywhere in the communication piping connecting abatement systems 12 and process tool (film formation device) 21. For example, exhaust gas separation device 11 may be provided for each abatement system 12, or may be provided at a collection part where two or more abatement systems 12 are connected. Similarly, in the many-to-one connection configuration in which abatement

systems 12 and process tool (dry etching) 21 are arranged, exhaust gas separation device 11 may be provided anywhere in the communication piping connecting abatement systems 12 and process tool (dry etching) 21. For example, exhaust gas separation device 11 may be provided for each abatement system 12, or may be provided at a collection part where two or more abatement systems 12 are connected.

[0053]

Furthermore, although not shown in FIG. 9, abatement system 12 and process tools (film formation devices) 21 may be arranged in a one-to-many connection configuration. Abatement system 12 and process tools (dry etching) 21 may similarly be arranged in a one-to-many connection configuration. In any connection configuration, exhaust gas separation device 11 may be provided for at least one process tool 21.

Furthermore, the connection between abatement systems 12, process tools (film formation devices) 21, and process tools (dry etching) 21 may be a combination of two or more from among the four one-to-one, one-to-many, many-to-one, and many-to-many connection configurations. In this case, exhaust gas separation device 11 may be provided for at least one process tool 21.

In addition, in each of the above-mentioned connection configurations, exhaust gas separation device 11 may be incorporated within at least one process tool 21.

[0054]

A specific example of the arrangement of exhaust gas separation device 11 is next described.

FIG. 10 is a schematic diagram showing an example of the arrangement of exhaust gas separation device 11. In FIG. 10, the solid arrows schematically show piping through which gas passes, and one solid line may represent a single pipe or multiple pipes.

In the example shown in FIG. 10, two abatement systems 12 and three process tools 21 are connected in a many-to-many configuration. Film formation devices or dry etching devices can be used for process tools 21. Arrangement positions A1 to A6 indicate positions where exhaust gas separation device 11 can be arranged. Arrangement positions A1 and A2 indicate arrangement of two abatement systems 12 on the gas feed piping. Arrangement position A3 indicates arrangement at the collection part of the piping from each process tool 21. Arrangement positions A4 to A6 each indicate arrangement on the piping from

respective process tool 21.

[0055]

Exhaust gas separation device 11 may be provided at any of arrangement positions A1 to A6. Also, exhaust gas separation devices 11 may be provided at two or more of arrangement positions A4 to A6. Furthermore, exhaust gas separation devices 11 may be provided at both arrangement positions A1 and A2. Note that there may be two or more process tools 21. In this case, exhaust gas separation device(s) 11 may be provided for one or more process tools 21. Furthermore, there may be three or more abatement systems 12. In this case, exhaust gas separation device(s) 11 may be provided for one or more abatement systems 12.

[0056]

FIG. 11 is a schematic diagram showing another example of the arrangement of exhaust gas separation device 11. In FIG. 11, the solid arrows schematically show piping through which gas passes.

In the example shown in FIG. 11, arrangement positions A1 to A9 of exhaust gas separation device 11 relative to one process tool (film forming device) 21 are shown. Process tool (film formation device) 21 has four chambers 21a. Pump 30 is provided in the piping on the discharge side of each chamber 21a. The piping on the discharge side of each pump 30 merges into one. Arrangement position A1 indicates the arrangement relative to the collection part of the piping from each pump. Arrangement positions A2 to A5 each indicate arrangement relative to the piping on the discharge side of respective pumps 30. Placement positions A6 to A9 each indicate arrangement relative to the piping on the discharge side of respective chambers 21a.

Exhaust gas separation device 11 may be provided at any of arrangement positions A1 to A9. Exhaust gas separation devices 11 may also be provided at two or more of arrangement positions A2 to A5. Furthermore, exhaust gas separation devices 11 may be provided at two or more of arrangement positions A6 to A9. Note that there may be two or more chambers 21a, in which case, exhaust gas separation device(s) 11 may be provided for one or more chambers 21a.

[0057]

FIG. 12 is a schematic diagram showing yet another example of the arrangement of exhaust gas separation device 11. In FIG. 12, the solid arrows schematically show piping through which gas passes. Chambers 21a, pumps 30,

and piping are the same as shown in FIG. 11. Valve 31 is provided in the piping from each pump 30, and two pipes are provided that connect to exhaust gas separation device 11, one before and one after each of these valves 31. One of the two pipes is a feed line, and the other is a discharge line. Valve 32 is provided in each feed line, and valve 33 is provided in each discharge line. Each feed line is connected to one line that connects to exhaust gas separation device 11. Each discharge line is also connected to one line that connects to exhaust gas separation device 11.

By operating three valves 31 to 33 provided for each chamber 21a, each chamber 21a can be individually connected to exhaust gas separation device 11. For example, when a cleaning process is sequentially performed for each chamber 21a, chamber 21a to be subjected to the cleaning process is connected to exhaust gas separation device 11. This allows for efficient recovery (separation) of exhaust gas. Furthermore, according to this arrangement, the amount of exhaust gas is the smallest compared to the arrangements shown in FIGs. 10 and 11, and the concentration of the gas to be treated (load amount) can be increased, whereby the recovery equipment can be reduced in scale and recovery efficiency can be improved.

In the arrangement shown in FIG. 12, a path switching unit using valves 31 to 33 may be provided for at least one chamber 21a. Furthermore, the number of chambers 21a is not limited to four, and two or more chambers 21a may be provided.

[0058]

FIG. 13 is a schematic diagram showing yet another example of the arrangement of exhaust gas separation device 11. In FIG. 13, the solid arrows schematically show piping through which gas passes, and one solid line may represent a single pipe or multiple pipes. Abatement systems 12, process tools 21, and piping are the same as shown in FIG. 10.

In the example shown in FIG 13, valve 31 is provided at the collection part of the piping from each process tool 21, and two pipes are provided leading from this valve 31 toward exhaust gas separation device 11. One of the two pipes is a feed line, and the other is a discharge line. Valve 32 is provided in the feed line, and valve 33 is provided in the discharge line. By operating the three valves 31 to 33, each process tool 21 can be connected to exhaust gas separation device 11.

[0059]

For example, valve 31 may be set to remain closed at all times, while valves 32 and 33 may be set to remain open at all times, whereby exhaust gas from each process tool 21 always passes through exhaust gas separation device 11. Valve 31 may be closed and valves 32 and 33 may be opened only during the time when the amount of exhaust gas from each process tool 21 is high, with the result that exhaust gas from each process tool 21 always passes through exhaust gas separation device 11.

Note that a path switching unit using valves 31 to 33 can also be provided in piping other than at the collection part of the piping. For example, the path switching unit may be provided in at least one of arrangement positions A1, A2, and A4 to A6 shown in FIG. 10.

[0060]

Furthermore, a path switching unit having valves 31 to 33 may also be applied in the one-to-one connection configuration, the one-to-many connection configuration, and the many-to-many connection configuration described with reference to FIG. 9. For example, a path switching unit having valves 31 to 33 may be provided as necessary for at least one piping in the one-to-one connection configuration, the one-to-many connection configuration, and the many-to-many connection configuration.

Furthermore, in the one-to-one connection configuration, the one-to-many connection configuration, and the many-to-many connection configuration, piping that connects process tool 21 and abatement system 12 may be configured with an active line and a standby line. In this case, a path switching unit having valves 31 to 33 may be provided for each of the active line and the standby line. Specifically, the path switching unit may be provided at the collection part of the piping for the active lines, and similarly, a path switching unit may be provided at the collection part of the piping for the standby lines. During normal operation, the active lines are used, and the active lines are connected to exhaust gas separation device 11 as required. The standby lines are used during maintenance of the active lines, and the standby lines are connected to exhaust gas separation device 11 as required.

[0061]

Furthermore, in the one-to-one connection configuration, the one-to-many connection configuration, and the many-to-many connection configuration, a portion of the piping connecting between process tool 21 and abatement system 12 may be a piping structure in which multiple pipes are connected in parallel. In

this case, a path switching unit using valves 31 to 33 may be provided for each pipe in the piping structure. Specifically, the collection portion of the piping from each process tool 21 may have the above-described piping structure, and a path switching unit may be provided for each pipe in this piping structure.

Furthermore, in the one-to-one connection configuration, the one-to-many connection configuration, and the many-to-many connection configuration, exhaust gas separation device 11 is preferably provided in, of multiple process tools 21, process tool 21 in which the amount of a specific substance contained in first gas 22a is large.

As described above, application of this technology enables the reduction of plant costs, chemical amounts, and waste amounts of abatement system 12 and wastewater treatment facility 13. At the same time, CO_2 emissions caused by the operation of the device and facility can also be reduced.

Another Embodiment

[0062]

Both of the above-described exhaust gas treatment systems 10 and 10A can be realized by incorporating exhaust gas separation device 11 in an existing exhaust gas treatment system. In this additional embodiment, a method for retrofitting an exhaust gas treatment system using a combination of abatement system 12 and exhaust gas separation device 11 is described.

[0063]

The improvement method of this additional embodiment is a method for improving an exhaust gas treatment system that includes abatement system 12 that receives exhaust gas containing a specific substance and make-up water, combusts the exhaust gas to abate the specific substance, and discharges wastewater in which the abated specific substance is scrubbed in the make-up water, and wastewater treatment facility 13 that receives the wastewater, removes the specific substance from the wastewater, and recovers the wastewater from which the specific substance has been removed as make-up water, wherein the method includes providing exhaust gas separation device 11 that receives first gas 22a containing the specific substance, recovers a portion of the specific substance contained in first gas 22a, and discharges as exhaust gas to abatement system 12 second gas 22b having a lower content of the specific substance than first gas 22a. The recovery rate of the specific substance in exhaust gas separation device 11 is set such that the amount of the specific

substance supplied to abatement system 12 per unit time is less than the amount of the specific substance treated by abatement system 12 per unit time.

[0064]

According to the above-described method of incorporating the exhaust gas separation device, even if the amount of specific substance contained in the exhaust gas increases, the specific substance can be abated without altering existing equipment such as the discharge equipment of abatement system 12 or the recovery equipment of wastewater treatment facility 13. This effect will be explained in detail below.

[0065]

An example is here given in which the specific substance is fluorine. The feed amount of fluorine is assumed to be 2,000 kg/d, and the maximum amount of fluorine treated by abatement system 12 is assumed to be 1,000 kg/d. In this case, if the fluorine recovery rate of exhaust gas separation device 11 installed in the stage preceding abatement system 12 is set to 50%, fluorine can be removed by abatement system 12 without altering the existing equipment. In other words, the facilities that would otherwise need to be expanded in response to the increase in the amount of fluorine supplied can be scaled back so as to allow accommodation with the existing facilities, or the increase of load on the production side can be accommodated without adding new facilities for wastewater treatment and/or drainage.

Some or all of the above embodiments may also be described by, but are not limited to, the following Supplementary Notes.

(Supplementary Note 1)

An exhaust gas treatment system comprising:

an exhaust gas separation section that receives a first gas containing a specific substance, separates a portion of the specific substance contained in the first gas, and discharges a second gas having a lower content of the specific substance than the first gas;

a combustion section that treats the second gas to combust the specific substance;

a scrubbing section that scrubs the specific substance that has been combusted into feed water to discharge first wastewater; and

a wastewater treatment facility that receives the first wastewater, removes the specific substance from the first wastewater, and recovers wastewater from which the specific substance has been removed as make-up

water for the feed water.

(Supplementary Note 2)

The exhaust gas treatment system according to Supplementary Note 1, wherein the wastewater treatment facility is configured to discharge second wastewater containing the specific substance that was removed from the first wastewater,

the system further comprising a water treatment device that receives the second wastewater and performs a water treatment to remove the specific substance from the second wastewater.

(Supplementary Note 3)

The exhaust gas treatment system according to Supplementary Note 1 or 2, wherein the first gas is a gas generated in one or both of a thin-film formation process and a dry etching process.

(Supplementary Note 4)

The exhaust gas treatment system according to any one of Supplementary Notes 1 to 3, wherein an abatement system including the combustion section and the scrubbing section is connected to a process tool that discharges the first gas via the exhaust gas separation section.

(Supplementary Note 5)

The exhaust gas treatment system according to Supplementary Note 4, wherein a plurality of the abatement systems and a plurality of the process tools are arranged, and the plurality of the abatement systems and the plurality of the process tools are connected in any one connection form or in a combination of two or more connection forms from among a one-to-one connection form, a one-to-many connection form, a many-to-one connection form, and a many-to-many connection form,

wherein the exhaust gas separation section is incorporated in piping that is provided inside at least one of the plurality of process tools and through which a gas containing the specific substance flows, or in piping that extends from the process tool to the outside and through which a gas containing the specific substance flows.

(Supplementary Note 6)

The exhaust gas treatment system according to Supplementary Note 5, wherein the piping extends from each of the plurality of process tools, and the exhaust gas separation section is incorporated in a collection portion of the piping from each process tool.

(Supplementary Note 7)

The exhaust gas treatment system according to any one of Supplementary Notes 1 to 6, wherein the specific substance comprises one or both of at least one component selected from among fluorine, nitrogen, carbon, and silicon, and a compound of the component.

(Supplementary Note 8)

An exhaust gas treatment method comprising:

a step of receiving a first gas containing a specific substance, separating a portion of the specific substance contained in the first gas, and discharging a second gas having a lower content of the specific substance than the first gas;

a step of treating the second gas to combust the specific substance;

a step of scrubbing the specific substance that has been combusted into feed water to discharge first wastewater; and

a step of receiving the first wastewater, removing the specific substance from the first wastewater, and recovering wastewater from which the specific substance has been removed as make-up water for the feed water.

(Supplementary Note 9)

A method for retrofitting an exhaust gas treatment system comprising an abatement system that treats exhaust gas containing a specific substance to combust the specific substance, scrubs the combusted specific substance into feed water, and discharges first wastewater, and a wastewater treatment facility that receives the first wastewater, removes the specific substance from the first wastewater, and recovers wastewater from which the specific substance has been removed as make-up water for the feed water, said method comprising:

providing an exhaust gas separation device that receives a first gas containing the specific substance, separates a portion of the specific substance contained in the first gas, and discharges a second gas having a lower content of the specific substance than the first gas.

(Supplementary Note 10)

The method for retrofitting the exhaust gas treatment system according to Supplementary Note 9, wherein a recovery rate of the specific substance in the exhaust gas separation device is set such that an amount of the specific substance supplied to the abatement system per unit time is less than an amount of the specific substance treated by the abatement system per unit time.

[0066]

The present invention has been described above with reference to

embodiments, but the present invention is not limited to the above-described embodiments. The configuration and details of the present invention can be modified in various ways within the scope of the present invention that will be understandable to those skilled in the art.

[0067]

This application claims priority based on Japanese Patent Application No. 2023-201755, filed on November 29, 2023, the entire disclosure of which is incorporated herein by reference.

Explanation of Reference Numbers

[0068]

10 exhaust gas treatment system
11 exhaust gas separation device
12 abatement system
13 wastewater treatment facility
22a first gas
22b second gas
23a first wastewater
24 make-up water

CLAIMS

[Claim 1]

An exhaust gas treatment system comprising:

an exhaust gas separation section that receives a first gas containing a specific substance, separates a portion of the specific substance contained in the first gas, and discharges a second gas having a lower content of the specific substance than the first gas;

a combustion section that treats the second gas to combust the specific substance;

a scrubbing section that scrubs the specific substance, which has been combusted in the combustion section, into feed water and discharges first wastewater; and

a wastewater treatment facility that receives the first wastewater, removes the specific substance from the first wastewater, and recovers wastewater from which the specific substance has been removed as make-up water for the feed water.

[Claim 2]

The exhaust gas treatment system according to claim 1, wherein the wastewater treatment facility is configured to discharge second wastewater containing the specific substance that was removed from the first wastewater,

the system further comprising a water treatment device that receives the second wastewater and performs a water treatment to remove the specific substance from the second wastewater.

[Claim 3]

The exhaust gas treatment system according to claim 1 or 2, wherein the first gas is a gas generated in one or both of a thin-film formation process and a dry etching process.

[Claim 4]

The exhaust gas treatment system according to claim 1 or 2, wherein an abatement system including the combustion section and the scrubbing section is connected to a process tool that discharges the first gas via the exhaust gas separation section.

[Claim 5]

The exhaust gas treatment system according to claim 4, wherein a plurality of the abatement systems and a plurality of the process tools are arranged, and the plurality of the abatement systems and the plurality of the

process tools are connected in any one connection form or in a combination of two or more connection forms from among a one-to-one connection form, a one-to-many connection form, a many-to-one connection form, and a many-to-many connection form,

wherein the exhaust gas separation section is incorporated in piping that is provided inside at least one of the plurality of process tools and through which a gas containing the specific substance flows, or in piping that extends from the process tool to the outside and through which a gas containing the specific substance flows.

[Claim 6]

The exhaust gas treatment system according to claim 5, wherein the piping extends from each of the plurality of process tools, and the exhaust gas separation section is incorporated in a collection portion of the piping from each process tool.

[Claim 7]

The exhaust gas treatment system of claim 1 or 2, wherein the specific substance comprises one or both of at least one component selected from among fluorine, nitrogen, carbon, and silicon, and a compound of the component.

[Claim 8]

An exhaust gas treatment method comprising:

a step of receiving a first gas containing a specific substance, separating a portion of the specific substance contained in the first gas, and discharging a second gas having a lower content of the specific substance than the first gas;

a step of treating the second gas to combust the specific substance;

a step of scrubbing the specific substance, which has been combusted in the step of treating the second gas, into feed water and discharging first wastewater; and

a step of receiving the first wastewater, removing the specific substance from the first wastewater, and recovering wastewater from which the specific substance has been removed as make-up water for the feed water.

[Claim 9]

A method for retrofitting an exhaust gas treatment system comprising an abatement system that treats exhaust gas containing a specific substance to combust the specific substance, scrubs the specific substance that has been combusted into feed water, and discharges a first wastewater, and a wastewater treatment facility that receives the first wastewater, removes the specific

substance from the first wastewater, and recovers wastewater from which the specific substance has been removed as make-up water for the feed water, said method comprising:

providing an exhaust gas separation device that receives a first gas containing the specific substance, separates a portion of the specific substance contained in the first gas, and discharges a second gas having a lower content of the specific substance than the first gas.

[Claim 10]

The method for retrofitting the exhaust gas treatment system according to claim 9, wherein a recovery rate of the specific substance in the exhaust gas separation device is set such that an amount of the specific substance supplied to the abatement system per unit time is less than an amount of the specific substance treated by the abatement system per unit time.