removes a solid component from the exhaust gas that has been treated in the exhaust gas treatment unit; a treatment agent storage unit that stores a treatment agent for treating the exhaust gas; a treatment agent addition management unit comprising an exhaust gas analysis unit, wherein the exhaust gas analysis unit is disposed downstream of the exhaust gas recovery unit and analyzes at least an oxygen gas concentration in the exhaust gas, and wherein the treatment agent addition management unit calculates an amount of the treatment agent to be added necessary to treat an acid gas in the exhaust gas treated in the exhaust gas treatment unit based on an amount of change in the oxygen gas concentration analyzed in the exhaust gas analysis unit, and the treatment agent addition management unit gives an instruction to supply the calculated amount of the treatment agent; and a treatment agent supply unit that supplies the treatment agent in an amount instructed by the treatment agent addition management unit from the treatment agent storage unit to the exhaust gas treatment unit.

(2) In one example, the exhaust gas treatment system according to (1), wherein the exhaust gas analysis unit analyzes an oxygen gas concentration in the exhaust gas by means of a zirconia oximeter, the treatment agent addition management unit gives an instruction to supply the treatment agent when oxygen gas concentration starts to decrease, and the exhaust gas treatment unit treats the exhaust gas containing an acid gas with the treatment agent.

(3) In one example, the exhaust gas treatment system according to (1) or (2), wherein the treatment agent has a property of neutralizing an acid gas in the exhaust gas.

(4) In one example, the exhaust gas treatment system according to any of (1) to (3), wherein the acid gas is a sulfur oxide gas.

(5) In another aspect, the present disclosure includes an exhaust gas treatment method comprising: calculating an amount of a treatment agent to be added necessary to treat an acid gas in an exhaust gas treated in an exhaust gas treatment unit, based on an amount of change in an oxygen gas concentration analyzed in an exhaust gas analysis unit in a treatment agent addition management unit, wherein the exhaust gas analysis unit is disposed downstream of an exhaust gas recovery unit that separates gas from a solid component in the exhaust gas to recover and remove the solid component, and analyzes at least the oxygen gas concentration in the exhaust gas; giving an instruction to a treatment agent supply unit to supply the calculated

Fig. 1 is a view illustrating a structure of an exhaust gas treatment system for performing the exhaust gas treatment method of the present invention. In Fig. 1, of the lines connecting the respective blocks, the solid line represents the flow of a substance and the dashed line represents the flow of information.

The exhaust gas treatment system 1 according to the present embodiment using a treatment agent is mainly composed of a treatment agent addition management unit 13 comprising an incinerator F, an exhaust gas treatment unit 11, a treatment agent supply unit 14, a treatment agent storage unit 12, exhaust gas analysis units 131, 132, and an exhaust gas recovery unit 16. In addition, a flow meter 17 and a chimney 18 are provided. The structure of the exhaust gas treatment system 1 will be described in detail below.

[0013]

(Incinerator)

The incinerator F refers to a combustion facility such as a municipal waste incinerator, an industrial waste incinerator, a power boiler, a carbonization furnace and a private factory. Usually exhaust gas discharged from a municipal waste incinerator contains toxic acid gas such as hydrogen chloride (HCl), sulfur oxide (SO_x) and nitrogen oxide (NO_x), and solid components (hereinafter referred to as "fly ash") depending on the waste to be incinerated. Of them, sulfur oxide is included in the largest amount. The source of exhaust gas and components included therein are not particularly limited. The exhaust gas refers to gas generated by incinerating various types of waste. The "acid gas" means a gas which is acidic when dissolved in a solution, and

neutralized at the downstream thereof (e.g., in the flue from the exhaust gas treatment unit 11 to the exhaust gas recovery unit 16) as the treatment agent is transferred with exhaust gas. For example, this may be the case when slaked lime is used as the treatment agent because slaked lime reacts with acid gas slowly.

[0017]

Furthermore, exhaust gas may be treated by a continuous method. Alternatively, exhaust gas may be treated by a batch method using, for example, a closed container or various reactors for gas phase reaction. In any case, the amount of exhaust gas treated is not particularly limited, and may be appropriately designed considering the amount of exhaust gas produced by incineration of waste and the like.

[0018]

(Treatment agent storage unit)

The treatment agent storage unit 12 stores a treatment agent for treating exhaust gas. The exhaust gas treatment system 1 according to the present embodiment manages the treatment agent stored in the treatment agent storage unit 12. The treatment agent storage unit 12 is not particularly limited as long as it can store the treatment agent, and for example, a storage tank and a silo may be used. The capacity and the shape of the treatment agent storage unit 12 are not particularly limited, and may be appropriately designed considering the space where the system is built, the schedule of treatment of exhaust gas, the amount of exhaust gas to be treated, how often exhaust gas is treated and how often the treatment agent is ordered.

[0019]

(Treatment agent addition management unit)

concentration instead of sulfur oxide concentration, and when the analysis results suggest that the oxygen gas concentration starts to decrease, the treatment agent is added thereto based on the oxygen gas concentration. Examples of methods of analysis of oxygen gas concentration include a zirconia method, a magnetic method, laser spectroscopy and an electrode method. Any of the methods may be used, and a zirconia method is preferably used.

[0023]

In the zirconia method, a porous platinum electrode is attached and heated to both surfaces of a zirconia element, and when oxygen gas with a different partial pressure is brought into contact with the respective surfaces, an oxygen concentration cell is produced. The action of the cell produces electromotive force between electrodes, allowing analysis of oxygen gas concentration. Furthermore, a comparison of analysis results obtained in the exhaust gas analysis units 131 and 132 arranged at the upstream and the downstream of the exhaust gas treatment unit 11, respectively, allows more accurate calculation of the amount of the treatment agent needed to neutralize exhaust gas.

[0024]

Moreover, the amount of exhaust gas is analyzed in an exhaust gas flow meter 17 to improve the accuracy of calculation of the amount of the treatment agent to be used. There is little change in the amount of exhaust gas before and after addition of the treatment agent, and thus although the exhaust gas flow meter 17 is arranged together with the exhaust gas analysis unit 132 in Fig. 1, the position of the exhaust gas flow meter 17 is not limited to that example. By analyzing the amount of exhaust gas, the absolute amount of acid gas in exhaust gas can be

calculated together with analysis values of acid gas concentration, and this allow more accurate calculation of the mass of the treatment agent required.

[0025]

(Treatment agent supply unit)

The treatment agent supply unit 14 supplies the treatment agent in an amount instructed by the treatment agent addition management unit 13 from the treatment agent supply unit 12 to the exhaust gas treatment unit 11.

The structure of the treatment agent supply unit 14 may be those which can supply a predetermined amount of the treatment agent to the exhaust gas treatment unit 11 from the treatment agent storage unit 12, and is not particularly limited. It may be constituted by a volumetric feeder, a pump or a powder feeder.

[0026]

(Treatment agent)

The treatment agent has a property of neutralizing acid gas in exhaust gas. The treatment agent may be in the form of liquid or powder (solid), and it is necessary that the treatment agent has a component which allows calculation of the amount of the treatment agent by analyzing exhaust gas.

[0027]

Examples of treatment agents include, but are not limited to, calcium hydroxide, calcium oxide, calcium carbonate, magnesium hydroxide, magnesium oxide, magnesium carbonate, calcium hydroxide-magnesium hydroxide, calcium oxide-magnesium oxide, calcium carbonate-magnesium carbonate, sodium hydroxide, sodium hydrogen

[0032]

(Operation of exhaust gas treatment system)

The operation of the exhaust gas treatment system 1 in the exhaust gas treatment method will be described.

When exhaust gas is produced by incinerating waste in the incinerator F, the exhaust gas is treated through the following path. Exhaust gas generated in the incinerator F is cooled via a flue and a cooling tower (both not shown), and fly ash is removed or recovered in the exhaust gas recovery unit 16. Then the exhaust gas is transferred to the exhaust gas analysis unit 132 in the treatment agent addition management unit 13 through the exhaust gas recovery unit 16. The exhaust gas analysis unit 132 analyzes oxygen gas concentration in exhaust gas and then the treatment agent addition management unit 13 gives an instruction to add a treatment agent in an amount necessary to treat sulfur oxide in the exhaust gas based on the amount of change in oxygen gas concentration. Sulfur oxide in exhaust gas is neutralized in the exhaust gas treatment unit 11 with a treatment agent supplied from the treatment agent supply unit 14 based on the instruction from the treatment agent addition management unit 13. Then, the exhaust gas analysis unit 132 analyzes oxygen gas concentration or sulfur oxide concentration to verify that the sulfur oxide concentration in the exhaust gas is below the standard, and then the exhaust gas is discharged to the atmosphere through a chimney 18. Heavy metal and the like are fixed on fly ash which has been removed in the exhaust gas recovery unit 16, and the resultant is removed and buried.

[0033]

(Behavior of oxygen gas concentration)

However, the current analysis of sulfur oxide takes a few minutes, at least 4 minutes to obtain results depending on the analysis principle. During that time exhaust gas flows into the chimney 18 from the incinerator F through the exhaust gas recovery unit 16. Thus, exhaust gas to which no treatment agent has been added is discharged into the atmosphere after the start of analysis until results are obtained.

[0036]

(Time of analysis of oxygen gas concentration)

Thus, the exhaust gas treatment system 1 of the present embodiment focuses on oxygen gas in exhaust gas and measures and analyzes oxygen gas concentration, not sulfur oxide concentration in exhaust gas. For the method of measurement and analysis, a zirconia oximeter is provided at the upstream or the downstream of the exhaust gas analysis unit 132 in the exhaust gas treatment system 1 to conduct analysis. Usually in the analysis of oxygen gas concentration with a zirconia method, oxygen gas concentration can be analyzed in 2 minutes, which is shorter than the time taken for analysis of concentration of sulfur oxide. Thus, the time of analysis with an oximeter after exhaust gas reaches the exhaust gas analysis unit 132 can be short, and therefore even if the oximeter is located at the downstream of the exhaust gas recovery unit 16, the oximeter analyzes the oxygen gas concentration and provides analysis values, and then the treatment agent addition management unit 13 can give an instruction to the treatment agent supply unit 14 in a short time. The treatment agent supply unit 14 supplies a treatment agent and exhaust gas is treated in the exhaust gas treatment unit 11. This can reduce exhaust gas which is not neutralized

may also be used for management in the treatment agent addition management unit 13. When the treatment agent supply unit 14 is located near the site where exhaust gas is analyzed in terms of distance and time, the treatment agent can be immediately added to exhaust gas.

EXAMPLES

[0041]

Hereinafter the present invention will be described in detail with reference to Examples. The present invention is not limited by these Examples.

[0042]

To neutralize sulfur oxide in exhaust gas and recover it in the exhaust gas recovery unit, usually the amount of sulfur oxide is analyzed behind the exhaust gas recovery unit. In the control of sulfur oxide, feedback control systems such as PID based on the analysis results of sulfur are used to control the amount of the treatment agent to be added. In many cases sulfur oxide concentration has been analyzed at the downstream of the exhaust gas recovery unit and a treatment agent has been supplied to exhaust gas at the upstream of the exhaust gas recovery unit based on the analysis results. To compare the effect of analysis of oxygen gas concentration and sulfur oxide concentration at the downstream of the exhaust gas recovery unit, how the sulfur oxide concentration changed when the respective concentrations were analyzed and how slaked lime, which was the treatment agent, was consumed were studied.

[0043]

(Comparative Example 1)

CLAIMS

1. An exhaust gas treatment system comprising:

an exhaust gas treatment unit that treats an exhaust gas;

an exhaust gas recovery unit that separates and removes a solid component from the exhaust gas that has been treated in the exhaust gas treatment unit;

a treatment agent storage unit that stores a treatment agent for treating the exhaust gas;

a treatment agent addition management unit comprising an exhaust gas analysis unit, wherein the exhaust gas analysis unit is disposed downstream of the exhaust gas recovery unit and analyzes at least an oxygen gas concentration in the exhaust gas, and wherein the treatment agent addition management unit calculates an amount of the treatment agent to be added necessary to treat an acid gas in the exhaust gas treated in the exhaust gas treatment unit based on an amount of change in the oxygen gas concentration analyzed in the exhaust gas analysis unit, and the treatment agent addition management unit gives an instruction to supply the calculated amount of the treatment agent; and

a treatment agent supply unit that supplies the treatment agent in an amount instructed by the treatment agent addition management unit from the treatment agent storage unit to the exhaust gas treatment unit.

2. The exhaust gas treatment system according to claim 1, wherein the exhaust gas analysis unit analyzes an oxygen gas concentration in the exhaust gas by means of a zirconia oximeter, the treatment agent

addition management unit gives an instruction to supply the treatment agent when oxygen gas concentration starts to decrease, and the exhaust gas treatment unit treats the exhaust gas containing an acid gas with the treatment agent.

3. The exhaust gas treatment system according to claim 1 or 2, wherein the treatment agent has a property of neutralizing an acid gas in the exhaust gas.

4. The exhaust gas treatment system according to any of claims 1 to 3, wherein the acid gas comprises sulfur oxide.

5. An exhaust gas treatment method comprising:

calculating an amount of a treatment agent to be added necessary to treat an acid gas in an exhaust gas treated in an exhaust gas treatment unit, based on an amount of change in an oxygen gas concentration analyzed in an exhaust gas analysis unit in a treatment agent addition management unit, wherein the exhaust gas analysis unit is disposed downstream of an exhaust gas recovery unit that separates gas from a solid component in the exhaust gas to recover and remove the solid component, and analyzes at least the oxygen gas concentration in the exhaust gas;

giving an instruction to a treatment agent supply unit to supply the calculated amount of the treatment agent; and

supplying the instructed amount of the treatment agent from a treatment agent storage unit to the exhaust gas treatment unit, to thereby treat the acid gas in the exhaust gas.