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METHOD FOR TREATING A GAS

The present invention relates to a method for treating a gas, to effectively and safely neutralize a SO_3 component contained in e.g. a gas generated by combustion of fuel containing a sulfur content by e.g. a boiler.

When fuel containing a sulfur content is used, SO_3 is almost always contained in an exhaust gas, thus causing corrosion of an apparatus and air pollution. SO_3 will react with water vapor contained in the exhaust gas to form a sulfuric acid mist, which will form white smoke or violet smoke when discharged in the air. Accordingly, in order to remove SO_3 , it has conventionally been employed to preliminarily add to the fuel a slurry having e.g. an oxide or hydroxide of calcium or magnesium dispersed in an organic solvent, for prevention of SO_3 formation, or to neutralize SO_3 after combustion. However, with such methods, the additives are likely to deposit on a heat exchanger in the boiler, and when a large amount of the additives deposit thereon, the operation of the boiler

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will be hindered, and accordingly it is hard to use a large amount of the additives.

Further, to actively neutralize SO_3 in a flue, it has been employed to inject a powder of e.g. calcium hydroxide, magnesium oxide or magnesium hydroxide or a slurry having said powder dispersed in water, to the flue after the exhaust gas has passed through an air preheater. However, in the case where the powder itself is injected by this method, as the powder is injected by means of e.g. a screw feeder, quantitateness will be poor, and no stable effect is likely to be obtainable. Further, in the case of injecting the slurry, the powder contained in the slurry is likely to deposit on and clog the transportation line for injecting the slurry, whereby the method can hardly be carried out stably.

Further, in the case of using e.g. magnesium oxide, since magnesium oxide has a low reaction efficiency, it is necessary to add an excessive amount of a magnesium oxide powder. In such a case, unreacted magnesium oxide will remain in the flue, and may cause problems in post-treatment of magnesium oxide, since magnesium oxide has a low solubility in water. Further, it is difficult to quantify the injection amount of the powder.

Further, a method of gasifying ammonia and injecting it to the flue, may be mentioned. However, there are regulations in handling of e.g. a high-pressure gas and problems in view of working temperature, and there is a

possibility that acid ammonium sulfate may be formed and newly cause acid dust fall. Further, it is necessary to quench the gas after combustion between the flue and an exhaust gas desulfurizer, and a sulfuric acid mist may be
5 formed from SO_3 and water vapor in the atmosphere, and when the exhaust gas is discharged to the air from the exhaust gas desulfurizer through a smokestack, a streamer (trail) of white smoke or violet smoke may rise.

For the operation of a boiler, in order to prevent
10 lowering of the operating efficiency and to carry out operation safely, it is necessary to prevent formation of sulfuric acid mist due to cooling of the exhaust gas, by neutralizing and removing sulfur oxides, particularly SO_3 , and to prevent clogging of the flues or the
15 corrosion due to an acid at the side wall of the flues or in the steps until the exhaust gas is discharged. Further, when SO_3 is quenched and reacts with water vapor, sulfuric acid mist may form, and cause a streamer of white smoke or violet smoke when discharged from a
20 smokestack. Further, dust deposited on e.g. the flue will be discharged as acid smut containing a large amount of sulfuric acid by load change, whereby acid dust fall will be caused and the environment will be deteriorated, and it is important to suppress them in view of
25 environmental countermeasure.

Accordingly, a method has been desired to remove SO_3 and sulfuric acid mist by more effective and safe

neutralization treatment, from a gas containing SO_3 , such as a gas generated by using fuel containing a sulfur content in e.g. a boiler, including a combustion exhaust gas from fossil fuel, or a gas containing SO_3 as
5 impurities to be removed.

Accordingly, it is an object of the present invention to provide a method of effective and safe neutralization treatment of SO_3 and sulfuric acid mist in the above-mentioned gas.

10 The present invention provides a method for treating a gas containing a SO_3 component, which comprises adding a mixture of a sodium hydrogencarbonate powder having a mean particle diameter of at most 20 μm with an anti-caking agent for sodium hydrogencarbonate in an amount of
15 from 0.1 to 5 wt% based on the above-mentioned sodium hydrogencarbonate powder, to a gas of at least 60°C containing a SO_3 component for neutralization of the SO_3 component in the gas.

Now, the present invention will be described in
20 detail with reference to the preferred embodiments.

In the accompanying drawing:

Figure 1 is a flowchart illustrating a conventional method for treating an exhaust gas obtained by combustion in a boiler.

25 Here, SO_3 contained in the gas is present in the gas as sulfuric acid mist due to existence of water vapor. However, in the present specification, SO_3 and sulfuric

acid mist are generically referred to as a SO₃ component.

In the present invention, it is considered that when a sodium hydrogencarbonate powder is added to a gas of at least 60°C by e.g. spraying so that it is dispersed
5 therein, it undergoes decomposition to form sodium carbonate, carbon dioxide and water, whereupon the portions from which carbon dioxide and water have left become pores, and particles of sodium carbonate having a porous structure with a high porosity and a large
10 specific surface area, can be obtained. When the particles have a porous structure, absorbability of e.g. SO₃ will be high, and the SO₃ component can be removed by quick neutralization.

The sodium hydrogencarbonate powder of the present
15 invention has a mean particle diameter of at most 20 µm, preferably at most 15 µm, more preferably at most 10 µm. It is considered that sodium hydrogencarbonate having a mean particle diameter of at most 20 µm has a large specific surface area of the particles themselves, and a
20 large diameter of pores to be formed at the decomposition at a high temperature. Accordingly, it is considered that the diffusion rate of the SO₃ component will be high, and as a result, the reactivity will be high. The smaller the mean particle diameter of the sodium
25 hydrogencarbonate powder, the higher the diffusion rate of the SO₃ component, such being favorable. However, it is preferably at least 1 µm, in view of practicalness and

handling efficiency in pulverization of the powder.

The sodium hydrogencarbonate powder is added in an amount of preferably from 0.5 to 5 equivalent, particularly preferably from 1 to 4 equivalent, based on
5 the SO_3 component contained in the gas. If it is less than 0.5 equivalent, the SO_3 component can not adequately be removed. However, the sodium hydrogencarbonate in the present invention has a high reaction efficiency as compared with e.g. magnesium hydroxide, and accordingly
10 about 5 equivalent of the sodium hydrogencarbonate can almost completely remove the SO_3 component.

In the present invention, weak alkaline sodium hydrogencarbonate is used as a neutralizer for removing the SO_3 component. Accordingly, an operator can safely
15 handle it as compared with ammonia which is a poisonoum substance and regulated in handling as a high pressure gas and sodium hydroxide which is a deleterious substance.

In the present invention, to remove the SO_3 component
20 in the gas, an anti-caking agent for sodium hydrogencarbonate is added to the gas, together with sodium hydrogencarbonate. The particles of sodium hydrogencarbonate are likely to coagulate due to presence of a trace of moisture, whereby fluidity tends to be
25 poor. However, in the present invention, since coagulation of sodium hydrogencarbonate can be suppressed by the presence of the anti-caking agent, fluidity of

sodium hydrogencarbonate will improve, and sodium hydrogencarbonate can be dispersed well in the gas. As a result, a high reaction efficiency can be maintained.

The anti-caking agent is preferably fine particles
5 having a mean particle diameter of from 0.005 to 0.1 μm . When the fine particles having the above-mentioned particle diameter range are added as the anti-caking agent, said fine particles adhere to the surface of the sodium hydrogencarbonate particles, whereby coagulation
10 of the sodium hydrogencarbonate particles to other particles can be prevented.

As the anti-caking agent, specifically silica is preferred, and in the case of using silica, hydrophilic silica having a good dispersibility in water is
15 preferred. Although hydrophobic silica has high effects for improving fluidity of the sodium hydrogencarbonate, in a wet absorption tower of an exhaust gas desulfurizer in a boiler, for example, hydrophobic silica may coagulate on water and form a layer, and the layer may
20 cause foaming. As silica has hydrophilicity when it is not subjected to a hydrophobic treatment, one having no hydrophobic treatment applied thereto can be suitably used as the anti-caking agent in the present invention.

In the present invention, the anti-caking agent is
25 added in an amount of from 0.1 to 5.0 wt%, preferably from 0.3 to 2.0 wt%, based on the sodium hydrogencarbonate. If it is less than 0.1 wt%, effects

for improving fluidity of the sodium hydrogencarbonate
tend to be low. Further, if it exceeds 5.0 wt%, the
amount of the anti-caking agent will be too much, and the
fluidity of the sodium hydrogencarbonate is not
5 adequately improved, and the costs tend to be high.

In the present invention, since the sodium
hydrogencarbonate powder is added to the gas together
with the anti-caking agent, the powder will not
precipitate, unlike a slurry. Further, since the
10 fluidity is excellent, no clogging may form on the
apparatus, and since operation is carried out dryly, the
apparatus and the operation can easily be controlled, and
a stable operation can be carried out. Further, since a
good fluidity is imparted to the sodium hydrogencarbonate
15 powder, the sodium hydrogencarbonate can be injected
quantitatively, and e.g. SO_3 can be removed by
neutralization safely and surely.

Now, the method of the present invention will be
explained with reference to a method for treating an
20 exhaust gas produced by combustion of fuel in a boiler,
with reference to Figure 1. Figure 1 is a flowchart
illustrating a conventional method for treating an
exhaust gas obtained by combustion in a boiler.

An exhaust gas having a high temperature, combusted
25 in a boiler 1, is transported to an air preheater 2
through a first flue 6, and subjected to heat exchange
with an air for combustion transported to the boiler 1.

Then, the exhaust gas is transported to an electrical dust collector 3 through a second flue 7, and dust contained in the exhaust gas is removed by static electricity. The electrical dust collector 3 may not be
5 used depending upon the components contained in the exhaust gas. The exhaust gas passed through the electrical dust collector is transported to a desulfurizer 4 through a third flue 8, and e.g. SO_2 is removed by e.g. a magnesium hydroxide slurry. Then, the
10 exhaust gas is transported to a smokestack 5 through a fourth flue 9, and discharged from the smokestack 5.

When the exhaust gas is discharged as mentioned above, such a phenomenon that a long streamer of white smoke or violet smoke is rising from the smokestack 5,
15 may appear. It is considered that this is caused mainly by a sulfuric acid mist formed by reaction of SO_3 contained in the exhaust gas with water vapor contained in the atmosphere in the flues or the desulfurizer 4. Accordingly, generation of white smoke or violet smoke
20 can be prevented by adding the sodium hydrogencarbonate powder to the exhaust gas, for removal of SO_3 and the sulfuric acid mist.

In the above-mentioned process, the sodium hydrogencarbonate powder is added to at least one of the
25 four flues, and the flue to which the powder is added, is optionally selected depending upon the purpose. As it is an object of the present invention to remove the SO_3

component, it is preferred to add the sodium
hydrogencarbonate powder to a flue before the
desulfurizer, and it is particularly preferred to add the
powder to the third flue 8. It is necessary that the gas
5 in the flue is maintained to at least 60°C.

Further, by adding the sodium hydrogencarbonate
powder to the second flue 7 between the air preheater 2
and the electrical dust collector 3, acid dust fall can
be suppressed, charge failure of the electrical dust
10 collector 3 can be suppressed, and ammonia can be reduced.
In the case of suppressing the acid dust fall, it is
preferred to add the sodium hydrogencarbonate powder in
an amount of from 1 to 10 wt% to the amount of dust.

Now, the present invention will be described in
15 further detail with reference to Examples. However, it
should be understood that the present invention is by no
means restricted to such specific Examples.

EXAMPLE 1 (Working Example)

In order to confirm effects for removing a SO₃
20 component in a gas by addition of sodium
hydrogencarbonate, a test was carried out by using an
exhaust gas formed by combustion of fuel in a boiler.
Specifically, an exhaust gas was treated in the following
process, and to a flue between an air preheater and a
25 desulfurizer, a mixture comprising a sodium
hydrogencarbonate powder having a mean particle diameter
of 9 μm in an equivalent ratio as shown in Table 1, and

hydrophilic fumed silica having a mean particle diameter of 0.01 μm in an amount of 1.0 wt% based on the sodium hydrogencarbonate powder, was added with stirring by the air. Then, a streamer of white smoke (including violet
5 smoke) due to a sulfuric acid mist discharged from a smokestack was visually observed, and evaluation was carried out. In Table 1 is shown Comparative Example wherein no sodium hydrogencarbonate powder was added.

In Table 1, the addition amount of the sodium
10 hydrogencarbonate was represented by the equivalent ratio to SO_3 contained in the exhaust gas before it was transported to the desulfurizer (before it contacted with water vapor to form the sulfuric acid mist). The temperature of the gas in the flue between the air
15 preheater and the desulfurizer was 158°C.

PROCESS: an exhaust gas having a high temperature combusted in the boiler was transported to the air preheater through the flue, to carry out heat exchange with the air for combustion, and the exhaust gas was
20 transported to the desulfurizer through the next flue, to remove e.g. SO_2 by means of a magnesium hydroxide slurry, and the exhaust gas was transported to the smokestack through the next flue, and discharged from the smokestack.

The boiler to be used and the composition of the
25 exhaust gas were as follows.

Boiler

Model: forced-reflux benson boiler, amount of

evaporation: 83 t/h, vapor temperature: 520°C, vapor pressure: 140 kg/cm².

Composition of exhaust gas

O₂: 4.5%, SO₂: 1,400 ppm, SO₃: 20 ppm.

5 Table 1

Equivalent ratio of sodium hydrogencarbonate	Conditions of white smoke by visual observation
Not added	Streamer of about 300 m
1 equivalent	Streamer of about 150 m of white smoke with a half concentration or less based on the case where no sodium hydrogencarbonate was added
2 equivalent	Streamer of about 10 m as confirmed by careful observation
4 equivalent	No streamer

EXAMPLE 2 (Comparative Example)

The test was carried out in the same manner as in Example 1 except that sodium hydrogencarbonate having a mean particle diameter of 26 µm was used instead of the sodium hydrogencarbonate having a mean particle diameter of 9 µm. The results are shown in Table 2.

Table 2

Equivalent ratio of sodium hydrogencarbonate	Conditions of white smoke by visual observation
Not added	Streamer of about 300 m
1 equivalent	Streamer of about 300 m of white smoke with a concentration of 60-70% based on the case where no sodium hydrogencarbonate was added
4 equivalent	Streamer of about 200 m of white smoke with a half concentration or less based on the case where no sodium hydrogencarbonate was added

According to the present invention, SO_3 in a gas and a sulfuric acid mist derived therefrom can effectively, easily and safely be removed. Accordingly, a streamer of white smoke and violet smoke of an exhaust gas discharged from e.g. a boiler can be suppressed. Further, SO_3 in a gas containing SO_3 as impurities, in addition to the exhaust gas, can easily, safely and securely be removed, and such is useful in view of industrial production.



CLAIMS:

1. A method for treating a gas containing a SO_3 component, which comprises adding a mixture of a sodium hydrogencarbonate powder having a mean particle diameter
5 of at most 20 μm with an anti-caking agent for sodium hydrogencarbonate in an amount of from 0.1 to 5 wt% based on the sodium hydrogencarbonate powder, to a gas of at least 60°C containing a SO_3 component for neutralization of the SO_3 component in the gas.
- 10 2. The method for treating a gas according to Claim 1, wherein the sodium hydrogencarbonate is added to the gas, in an amount of from 0.5 to 5 equivalent based on the SO_3 component.
- 15 3. The method for treating a gas according to Claim 1 or 2, wherein the anti-caking agent is fine particles having a mean particle diameter of from 0.005 to 0.1 μm .
4. The method for treating a gas according to Claim 1, 2 or 3, wherein the anti-caking agent is silica.