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Abstract

The present invention provides a desulfurization apparatus 10 for desulfurizing a flue gas 13 containing sulfur oxides through contact with a porous carbon material 11. The carbon material 11, which is provided in a desulfurization tower 12, is at least one species selected from activated carbon and activated carbon fiber. The apparatus 10 contains an NO_2-gas-feeding apparatus 14 for feeding NO_2 gas into the desulfurization tower 12. Within the desulfurization tower 12, showering means 15 is provided at the top, the showering means adjusting the water content of the flue gas in the desulfurization tower to that corresponding to saturation with water vapor or higher at the treatment temperature.

Description

Desulfurization Apparatus and Desulfurization Method

Technical Field

The present invention relates to a desulfurization apparatus for removing sulfur oxides contained in a flue gas generated by a boiler or a similar facility employing a fuel such as coal, and to a method for desulfurizing the flue gas.

Background Art

Flue gases generated by boilers and thermal power stations employing a fuel such as coal or heavy oil, or by plants such as chemical-production plants, metal-processing plants, sintering plants, and paper-making plants contain a large amount of sulfur oxides such as sulfur dioxide. Among flue gas desulfurization methods for removing the sulfur oxides, there is disclosed a method in which a flue gas is brought into contact with a porous carbon material such as activated carbon or activated carbon fiber, to thereby cause the porous carbon material to adsorb sulfur oxides such as sulfur dioxide contained in the flue gas; the sulfur oxides are oxidized with oxygen contained in the flue gas in the presence of the porous carbon material serving as a catalyst; and the resultant oxides are absorbed in water, to thereby form sulfuric acid, which is removed from the carbon material (as disclosed in e.g., "Techniques and laws and regulations for Pollution Control," 3rd edition, air part 88, p. 112-113, Industrial Pollution control Association of Japan, and Japanese Patent Application Laid-Open (*kokai*) No. 10-230).

The reaction scheme of the desulfurization is as follows.

$$SO_2 + 1/2O_2 + H_2O \rightarrow H_2SO_4 \quad \cdots(1)$$

However, the desulfurization has a drawback in that, when nitrogen monoxide (NO) is contained in the flue gas, catalytic effect of the porous carbon material is deteriorated, thereby deteriorating desulfurization performance.

Specifically, FIG. 2 shows the relationship between NO content and the extent of the catalysis inhibition effect. As shown in FIG. 2, given that the amount of the porous carbon material catalyst is 1 when the NO content is 0 ppm, when NO content is 50 ppm the catalyst is required in an amount 1.2 times the above amount, and when NO content is 200 ppm the catalyst is required in an amount 1.5 times the above amount.

In other words, the desulfurization has a drawback in that an excess amount of porous carbon material must be used in order to maintain desulfurization performance, resulting in an increase in treatment costs.

In view of the foregoing, the present invention seeks to provide a desulfurization apparatus which attains effective desulfurization without deteriorating desulfurization performance even when a flue gas to be desulfurized contains a microamount of NO, and a desulfurization method.

Disclosure of the Invention

In a first aspect the present invention provides a desulfurization apparatus for desulfurizing a flue gas containing sulfur oxides through contact with a porous carbon material provided in a desulfurization tower, the porous carbon material being at least one species selected from activated carbon and activated carbon fiber, the apparatus being characterized by comprising an NO_2-gas-feeding apparatus for feeding NO_2 gas into the desulfurization tower.

According to this first aspect, an NO_2-gas-feeding apparatus for feeding NO_2 gas into the desulfurization tower is provided. Therefore, an effect of NO inhibiting performance of the porous carbon material is suppressed, thereby effectively desulfurizing a flue gas containing sulfur oxides.

The desulfurization apparatus may further comprise oxidizing-aid-feeding means for feeding, into the desulfurization tower, at least one oxidizing aid selected from among air, oxygen, ozone, aqueous hydrogen peroxide, an aqueous nitric acid solution, an aqueous permanganic acid solution, an aqueous chloric acid solution, and an aqueous hypochlorous acid solution. By employment of the oxidizing aid, desulfurization effect is enhanced.

Typically, the porous carbon material has been hydrophobicized by heating at 600-1,200°C in a non-oxidizing atmosphere. The thus-obtained hydrophobic surface facilitates adsorption of SO_2. In addition, the produced sulfuric acid can be removed at high efficiency, thereby promoting desulfurization reaction.

The desulfurization apparatus may further comprise water-supply means for adjusting the water content of the flue gas in the desulfurization tower to that corresponding to saturation of water vapor or higher. Thereby, desulfurization can be performed effectively.

The present invention also provides a flue gas treatment system for purifying a flue gas discharged from a boiler, a thermal power station, any of a variety of plants, or similar facilities, the system being characterized by comprising a desulfurization apparatus as in accordance with the present invention provided on a flue gas discharge line. Thereby, the efficiency of flue gas treatment is enhanced.

The flue gas treatment system of the present invention may further comprise an NO_x-removing apparatus on the downstream side of the desulfurization apparatus. Thereby, desulfurization and NO_x removal can be performed effectively.

The flue gas treatment system of the present invention may further comprise dust collecting means provided on any of the flue gas discharge lines. Thereby, in addition to desulfurization and NO_x removal, dust collection can be performed, thereby purifying flue gas.

The present invention also provides a desulfurization method for desulfurizing a flue gas containing sulfur oxides through contact with a porous carbon material provided in a desulfurization tower, the porous carbon material being at least one species selected from activated carbon and activated carbon fiber, wherein desulfurization is performed while an NO_2 gas is fed into the desulfurization tower. Thereby, inhibitory effect of NO for the porous carbon material is suppressed, thereby effectively desulfurizing a flue gas containing sulfur oxides.

In the desulfurization method of the present invention the porous carbon material may have been hydrophobicized by heating at 600-1,200°C in an non-oxidizing atmosphere. The thus-obtained hydrophobic surface facilitates adsorption of SO_2. In addition, the produced sulfuric acid can be removed at high efficiency, thereby promoting desulfurization reaction.

In the desulfurization method of the present invention water-supply means may be provided for adjusting the water content of the flue gas in the desulfurization tower to that corresponding to saturation of water vapor or higher. Thereby, desulfurization can be performed effectively.

Embodiments of the present invention are illustrated in the accompanying non-limiting drawings in which:

FIG. 1 is a schematic view of a flue gas desulfurization apparatus according to a first embodiment; and

FIG.2 is a graph showing the relationship between NO content and the amount of catalyst.

Best Modes for Carrying Out the Invention

In order to describe the present invention in more detail, the best modes for carrying out the invention will next be described with reference to the drawings appended hereto. However, the present invention is not limited to these modes.

FIG. 1 is a schematic view of a flue gas desulfurization apparatus according to a first embodiment. As shown in FIG. 1, a desulfurization apparatus 10 of the first embodiment for desulfurizing a flue gas 13 containing sulfur oxides through contact with a porous carbon material 11 provided in a desulfurization tower 12, the porous carbon material 11 being at least one species selected from activated carbon and activated carbon fiber, contains an NO_2-gas-feeding apparatus 14 for feeding NO_2 gas into the desulfurization tower 12. Within the desulfurization tower 12, showering means 15 is provided at the top, the showering means adjusting the water content of the flue gas in the desulfurization tower to that corresponding to saturation with water vapor or higher at the treatment temperature.

The aforementioned porous carbon material 11 adsorbs sulfur oxides contained in the flue gas and serves as an oxidation catalyst.

No particular limitation is imposed on the type of activated carbon used as the porous carbon material 11, and a variety of known activated carbon species can be used. Examples of the activated carbon species include those produced from raw material such as coconut husks, coke, and pitch. These activated carbon species can be produced through any known methods. Generally, these can be produced through steam-activation of the raw material. Although customary commercial activated carbon having a specific surface area of approximately 700 m^2/g or more can be used in the present invention, activated carbon species having a comparatively large specific surface area; e.g., approximately 1,500 m^2/g or more, are particularly preferred.

No particular limitation is imposed on the type of activated carbon fiber, and known activated carbon fibers such as those produced from pitch, polyacrylonitrile, phenol, or cellulose can be used. Commercial carbon fiber products can also be used.

Among them, activated carbon fiber species having a comparatively large specific surface area; e.g., approximately 1,000 m^2/g or more, are preferred. Activated carbon fiber species having high surface hydrophobicity such as those produced from pitch are also preferred.

The carbon materials selected from the aforementioned activated carbon species and activated carbon fiber species may be used, singly or in combination of two or more species, as the porous carbon material of the present invention.

The porous carbon material which is used in the present invention is preferably hydrophobicized. Specifically, the carbon material can be hydrophobicized by heating at approximately 600-1,200°C in a non-oxidizing atmosphere such as nitrogen gas or argon gas for approximately 0.5-5 hours. Through such heat treatment, a portion or the entirety of oxygen-containing functional groups serving as hydrophilic groups and contained in the porous carbon material are removed in forms such as CO and CO_2. Thus, the surface of the porous carbon material becomes more hydrophobic as compared with the state before the heat treatment. The thus-obtained hydrophobic surface facilitates oxidation of SO_2 and adsorption of SO_2 onto activated carbon, and the produced sulfuric acid can be removed at high efficiency, thereby promoting catalytic desulfurization reaction.

In the method of the present invention, the sulfur-oxide-containing flue gas to be treated is brought into contact with the aforementioned porous carbon material, to thereby achieve desulfurization. The sulfur oxide contained in the flue gas that has been in contact with the porous carbon material is adsorbed to the porous carbon material. The adsorbed sulfur oxide is reacted with water and oxygen contained in the flue gas, forming sulfuric acid in accordance with the following scheme (1).

$$SO_2 + 1/2O_2 + H_2O \rightarrow H_2SO_4 \cdots (1)$$

In addition, since NO_2 gas is intentionally fed into the desulfurization tower 12 from the NO_2-gas-feeding apparatus 14, inhibitory effect of NO against oxidation of SO_2 is suppressed, and SO_2 is reacted to from SO_3 and NO in accordance with the following scheme (2):

$$SO_2 + NO_2 \rightarrow SO_3 + NO \cdots (2),$$

leading to effective proceeding of desulfurization reaction.

In the reaction, supply of NO_2 gas results in formation of NO. However, in order to meet environmental quality standards, NO is removed through insertion of the below-mentioned NO_x-removing apparatus.

The method for bringing a flue gas containing sulfur oxide into contact with a porous carbon material is not limited to a method based on the configuration shown in FIG. 1, and any known method can be appropriately employed. Specifically, a flue gas is brought into contact with a porous carbon material through a customary method making use of a known reactor such as an immobilized-bed flow reactor, a fluidized-bed reactor, or an agitation reactor.

No particular limitation is imposed on the type of flue gas to be treated, and the target flue gases for treatment include all the flue gases containing sulfur oxides such as SO_2; e.g., flue gases generated by boilers and thermal power stations employing a fuel such as coal or heavy oil, or flue gases generated by plants such as chemical-production plants, metal-processing plants, sintering plants, and paper-making plants. No particular limitation is imposed on the SO_2 content of the flue gas. Generally, a flue gas can be desulfurized though the method of the present invention so long as the SO_2 content is approximately 100-2,000 ppm (typical level). In relation to the water content of the flue gas, when a flue gas has a water content of approximately 7.5 vol.% or more (typical level), the gas can be treated. A small amount of water is preferably supplied so as to promote desulfurization. Particularly, water is preferably supplied such that the water content of the flue gas is adjusted to that corresponding to saturation with water vapor or more at the treatment temperature.

Even when the water content of the flue gas is insufficient, treatment of the gas is possible if an appropriate amount of water is supplied by means of showering means 15 or similar means.

In addition to the aforementioned gas components, other gas components may coexist without posing particular problems, so long as the gases do not inhibit desulfurization reaction. For example, coexistence of nitrogen, carbon dioxide, or carbon monoxide poses no problems.

Furthermore, an oxidizing aid 16 can be supplied into the desulfurization tower 12 through oxidizing-aid-supplying means 17. By supply of the oxidizing aid, the oxidizing aid is incorporated into the flue gas during contact with the porous carbon material, thereby shifting the equilibrium of the reaction of the aforementioned scheme (1) to the right side, further promoting sulfuric acid formation; i.e., removal of SO_2.

Any oxidizing aid which is in gaseous form at ambient temperature or in liquid form at ambient temperature may be used as the oxidizing aid 16.

Examples of oxidizing aids which are in gaseous form at ambient temperature include air, oxygen, and ozone. Examples of oxidizing aids which are in liquid form at ambient temperature and can be used in the present invention include aqueous hydrogen peroxide, an aqueous nitric acid solution, an aqueous permanganic acid solution, an aqueous chloric acid solution, and an aqueous hypochlorous acid solution. In the present invention, oxidizing aids such as air, oxygen, ozone, aqueous hydrogen peroxide, an aqueous nitric acid solution, an aqueous permanganic acid solution, an aqueous chloric acid solution, and an aqueous hypochlorous acid solution, as described above, can be used singly or in combination of two or more species. Furthermore, a gaseous-form oxidizing aid and a liquid-form oxidizing aid may be used in combination.

The oxidizing aids which are in gaseous form at ambient temperature may be blown into a flue gas from a gas inlet of the desulfurization apparatus by means of a fan, a blower, a pressure feeder, etc. The oxidizing aids which are in liquid form at ambient temperature may be injected into a flue gas from a gas inlet of the desulfurization apparatus by means of a liquid-feeding pump, etc. Typically, the liquid-form oxidizing aids are added to replenishment water for supplying water to the flue gas, and the resultant mixture is atomized, to form a mist, which is then added to the flue gas.

Among these oxidizing aids, air, oxygen, etc. serve as a source for directly compensating oxygen deficiency and can elevate the oxygen content of the flue gas when added thereto. Air or oxygen may be added in an amount such that the resultant flue gas attains an oxygen content of approximately 5 vol.% or more, preferably approximately 8 vol.% or more. Since flue gases generally contain oxygen at a concentration of approximately 3 vol.% or more, the oxygen deficiency is compensated through addition of air or oxygen. Typically, atmospheric air can be used. In relation to oxygen, oxygen obtained from a source such as an oxygen bomb, liquid oxygen in a tank, or an oxygen generator may be used. In view that the atmosphere has an oxygen content of approximately 21%, when oxygen is used, the oxygen may be supplied in an amount of approximately 1/5 times the amount of air required.

Ozone having a remarkably high oxidation ability directly oxidizes SO_2 and decomposes on the surface of the porous carbon material, to thereby generate oxygen. Since ozone has an oxidation ability much higher than that of oxygen, the amount of ozone required to be added is smaller than that of oxygen to be added. Specifically, ozone is added in an amount such that the ozone content is adjusted to be comparable to the SO_2 content of the flue gas to be treated, typically such that the ozone content of the flue gas falls within a range of approximately 100 to 2,000 ppm. Ozone produced from a typical ozonizer for producing ozone by irradiating air with UV rays or similar radiation may be used.

Among liquid-form oxidizing aids, aqueous hydrogen peroxide is similar to ozone, in that it has a high oxidation ability, oxidizes SO_2, and generates oxygen. An aqueous nitric acid solution oxidizes SO_2 by its strong oxidation ability, thereby promoting formation of sulfuric acid. Similarly, aqueous acid solutions such as an aqueous permanganic acid solution, an aqueous chloric acid solution, and an aqueous hypochlorous acid solution have oxidation ability and decompose on the surface of the porous carbon material, thereby generating oxygen. A portion of the thus-generated oxygen gas is dissolved in each aqueous solution, to thereby form dissolved oxygen, which is remarkably effective for formation of aqueous sulfuric acid.

The liquid-form oxidizing aid is diluted with water, to thereby form an aqueous solution thereof, and the solution is added to the flue gas via spraying. Typically, the liquid-form oxidizing aid is added to replenishment water for supplying water to the flue gas, and the resultant mixture is added. No particular limitation is imposed on the concentration of the aqueous solution of a liquid-form oxidizing aid that is added to the flue gas. The effective component concentration of each aqueous solutions (e.g., aqueous hydrogen peroxide, an aqueous nitric acid solution, and an aqueous permanganic acid solution) is preferably adjusted to approximately 0.1-10 wt.%. The effective component concentration of each aqueous solution (e.g., an aqueous chloric acid solution and an aqueous hypochlorous acid solution) is preferably adjusted to approximately 0.1-20 wt.%. However, in order to store such an aqueous solution in the vicinity of a flue-gas-generating facility, a liquid tank of large capacity is required. Thus, preferably, an aqueous solution containing the liquid-form oxidizing aid having a concentration of approximately 20-40 wt.% is stored, the solution is diluted with water before use thereof, and the diluted solution is added to the flue gas.

The amount of the added liquid-form oxidizing aid is smaller than that of the added gas-form oxidizing aid, and the liquid-form oxidizing aid is added only in an amount such that the effective component amount of the oxidizing aid is equimol (chemical equivalent) or less based on the amount of SO_2 to be treated. Typically, the liquid-form oxidizing aid is added in an amount such that the effective component of the oxidizing aid is contained in the flue gas in an amount of approximately 0.1-10 vol.% as reduced to the amount of its vaporized species.

Among the aforementioned oxidizing aids, at least one species selected from among ozone, aqueous hydrogen peroxide, an aqueous nitric acid solution, an aqueous permanganic acid solution, an aqueous chloric acid solution, and an aqueous hypochlorous acid solution is preferably used in the present invention, since these oxidizing aids effectively remove sulfur oxides by use thereof in small amounts.

The treatment temperature during desulfurization must be appropriately adjusted in accordance with the type of the porous carbon material employed, the water content of the flue gas, the SO_2 content, and other factors. In general, treatment temperatures of approximately 20-100°C are suitable. Particularly in the present invention, desulfurization can be performed effectively even at ambient temperatures or thereabouts of approximately 30-60°C. Even when the treatment temperature is as high as 100°C or higher, desulfurization can be performed by intermittently adding a large amount of water through showering or similar means.

The flow rate of the gas during desulfurization is appropriately adjusted in accordance with the SO_2 content, the type of the desulfurization apparatus employed, and other factors. Generally, the gas is preferably passed under conditions such that W/F (wherein W denotes the weight of porous carbon material and F denotes the flow rate of gas) falls within a range of approximately 1×10^{-3} to 5×10^{-3} g·min/ml.

As described hereinabove, the present invention is particularly suited for removing sulfur oxides contained in flue gases generated by boilers and thermal power stations employing a fuel such as coal or heavy oil; and flue gases generated by plants such as chemical-production plants, metal-processing plants, sintering plants, and paper-making plants.

[Examples and Comparative Examples]

Embodiments of the present invention will next be described in more detail by way of non-limiting examples.

Granular activated carbon (Particle size: 8-32 mesh, specific surface area 800 m^2/g) was employed as a porous carbon material. The activated carbon was heated in advance at 1,000°C in a nitrogen atmosphere, to thereby impart a hydrophobic surface to the activated carbon. Subsequently, desulfurization was performed by use of the thus-prepared activated carbon through the following method, and desulfurization performance was investigated.

An immobilized-bed-flow-type desulfurization apparatus was employed. A gas having predetermined compositional conditions at an inlet (SO_2: 800 ppm, water content: 13.5 vol.% (higher than saturation), O_2: 3.8 vol.%, CO_2: 8 vol.%, and balance: N_2) was caused to flow at 50°C such that W/F (wherein W denotes the weight of porous carbon material and F denotes the flow rate of gas) was controlled to 2.5×10^{-3} g·min/ml, and desulfurization of the gas was carried out.

The SO_2 content of the apparatus outlet gas was measured by means of a non-dispersion infrared SO_2-meter, and percent desulfurization (= precent removal of SO_2) was calculated.

[Comparative Example 1]

Desulfurization was performed in the above manner, except that no oxidizing aid was used. Percent desulfurization 50 hours after initiation of desulfurization was measured.

[Example 1]

Desulfurization was repeated in the same manner as described above, except that NO_2 gas was fed in an amount such that the oxygen content of the entire reactive gas was adjusted to 800 ppm. Percent desulfurization 50 hours after initiation of desulfurization was measured.

The results are shown in Table 1.

[Table 1]

		Comparative Example 1	Example 1
		None	NO_2
Concentration	ppm	—	800
Percent removal of SO_x	%	95	98
SV value	h^{-1}	1,000	5,000
Relative amount of catalyst	—	1	0.2

*Gas conditions

- ·SO_2 800 ppm
- ·H_2O: 13.5% (higher than saturation)
- ·O_2: 3.8%
- ·CO_2: 8%
- ·Balance: nitrogen

As shown in Table 1, efficiency of removing sulfur oxides contained in the flue gas (i.e., desulfurization) could be enhanced by feeding NO_2 gas, and desulfurization could be performed generally at a percent desulfurization of approximately 98% or higher.

[Comparative Example 2]

Desulfurization was repeated in the same manner as described above, except that the aforementioned gas was modified such that the NO content was adjusted to 200 ppm. Percent desulfurization 50 hours after initiation of desulfurization was measured.

[Comparative Example 3]

Desulfurization was repeated in the same manner as described above, except that ozone serving as an oxidizing aid was blown from an ozonizer to reaction gas in an amount such that the ozone content of the entire reaction gas was adjusted to 1,000 ppm. Percent desulfurization 50 hours after initiation of desulfurization was measured.

[Comparative Example 4]

Desulfurization was repeated in the same manner as described above, except that oxygen serving as an oxidizing aid was fed to reaction gas in an amount such that the oxygen content of the entire reaction gas was adjusted to 8 vol.%. Percent desulfurization 50 hours after initiation of desulfurization was measured.

The results are shown in Table 2.

[Table 2] In the presence of NO

		Comparative Example 2	Comparative Example 3	Comparative Example 4
		None	Ozone	Oxygen
Concentration	ppm	—	1,000	8%
Percent removal of SO_x	%	95	96	95
SV value	h^{-1}	500	1,200	800
Relative amount of catalyst	—	1	0.42	0.625

*Gas conditions

- SO_2: 800 ppm
- H_2O: 13.5% (higher than saturation)
- O_2: 3.8%
- CO_2: 8%
- Balance: nitrogen

As shown in Table 2, inhibition of the catalyst due to NO and decrease in SV value were observed. No remarkable effect of oxidizing aids commensurate with addition was exerted.

Industrial applicability

As described hereinabove, the present invention suitably provides a desulfurization apparatus for desulfurizing a flue gas containing sulfur oxides through contact with a porous carbon material provided in a desulfurization tower, the porous carbon material being at least one species selected from activated carbon and activated carbon fiber, wherein an effect of NO inhibiting performance of the porous carbon material is suppressed by feeding NO_2 gas into the desulfurization tower, thereby effectively desulfurizing the flue gas containing sulfur oxides.

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

The reference to any prior art in this specification is not, and should not be taken as, an acknowledgment or any form of suggestion that that prior art forms part of the common general knowledge in Australia.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A desulfurization apparatus for desulfurizing a flue gas containing sulfur oxides through contact with a porous carbon material provided in a desulfurization tower, the porous carbon material being at least one species selected from activated carbon and activated carbon fiber, the apparatus being characterized by comprising an NO_2-gas-feeding apparatus for feeding NO_2 gas into the desulfurization tower.

2. A desulfurization apparatus according to claim 1, which further comprises oxidizing-aid-feeding means for feeding, into the desulfurization tower, at least one oxidizing aid selected from among air, oxygen, ozone, aqueous hydrogen peroxide, an aqueous nitric acid solution, an aqueous permanganic acid solution, an aqueous chloric acid solution, and an aqueous hypochlorous acid solution.

3. A desulfurization apparatus according to claim 1 or 2, wherein the porous carbon material has been hydrophobicized by heating at 600-1,200°C in a non-oxidizing atmosphere.

4. A desulfurization apparatus according to any one of claims 1 to 3, which further comprises water-supply means for adjusting the water content of the flue gas in the desulfurization tower to that corresponding to saturation of water vapor or higher.

5. A desulfurization apparatus according to claim 1 substantially as hereinbefore described.

6. A flue gas treatment system for purifying a flue gas discharged from a boiler, a thermal power station, any of a variety of plants, or similar facilities, characterized by comprising a desulfurization apparatus as recited in any one of claims 1 to 5 provided on a flue gas discharge line.

7. A flue gas treatment system according to claim 6, which further comprises an NO_x-removing apparatus on the downstream side of the desulfurization apparatus.

8. A flue gas treatment system according to claim 6 or 7, which further comprises dust collecting means provided on any of the flue gas discharge lines.

9. A flue gas treatment system according to claim 6 substantially as hereinbefore described.

10. A desulfurization method for desulfurizing a flue gas containing sulfur oxides through contact which a porous carbon material provided in a desulfurization tower, the porous carbon material being at least one species selected from activated carbon and activated carbon fiber, wherein desulfurization is performed while an NO_2 gas is fed into the desulfurization tower.

11. A desulfurization method according to claim 10, wherein the porous carbon material has been hydrophobicized by heating at 600-1,200°C in an non-oxidizing atmosphere.

12. A desulfurization method according to claim 10 or 11, wherein water-supply means is provided for adjusting the water content of the flue gas in the desulfurization tower

to that corresponding to saturation of water vapor or higher.

13. A desulfurization method according to claim 10 substantially as hereinbefore described.

DATED this 26th day of February, 2004
Osaka Gas Co. Ltd.
By DAVIES COLLISON CAVE
Patent Attorneys for the Applicant

FIG. 1

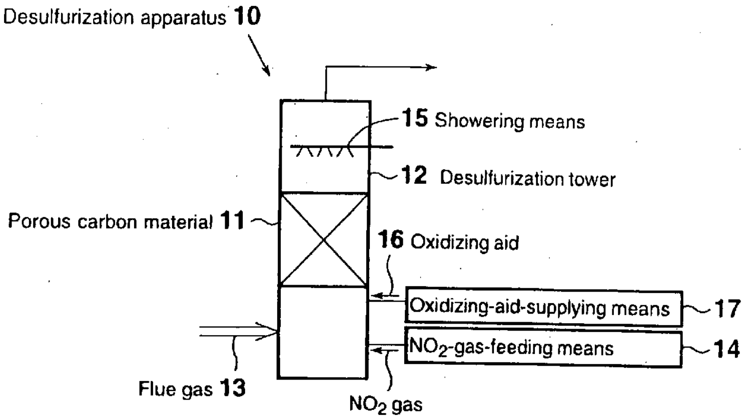
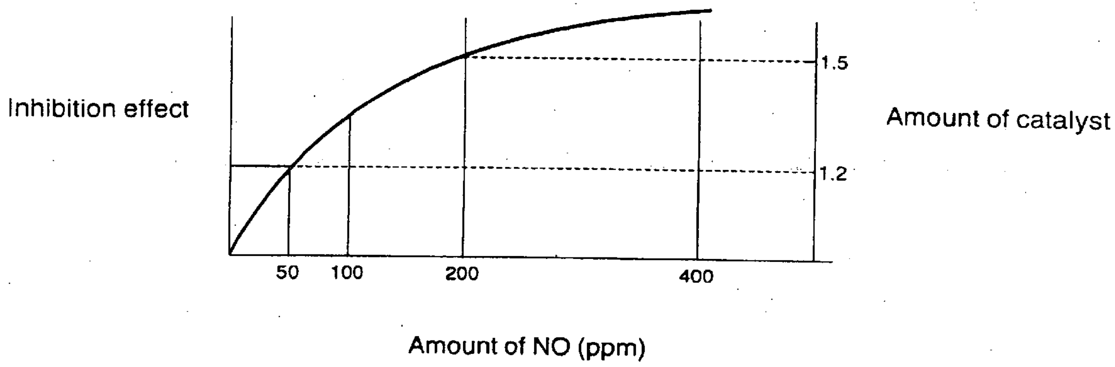

Desulfurization apparatus 10
15 Showering means
12 Desulfurization tower
Porous carbon material 11
16 Oxidizing aid
Oxidizing-aid-supplying means
17
NO2-gas-feeding means
14
Flue gas 13
NO2 gas

FIG. 2


Inhibition effect
Amount of catalyst
1.5
1.2
50
100
200
400
Amount of NO (ppm)