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54 **Combustion method for specific exhaust gases containing deleterious substances.**

57 A method for the combustion of specific exhaust gases such as silane-containing exhaust gases discharged from a reaction furnace in which a combustible gas is supplied to and burnt around the top end of a nozzle for the exhaust gases, thereby forming a flame barrier around the top end of the nozzle, and the exhaust gases are introduced from the top end of the nozzle to the inside of the flame barrier to be compulsorily burnt by the flame ahead of the barrier of the flame atmosphere.

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COMBUSTION METHOD FOR SPECIFIC EXHAUST GASES CONTAINING DELETERIOUS SUBSTANCES

BACKGROUND OF THE INVENTION

5 Field of the Invention

The present invention concerns a method for combustion of exhaust gases containing deleterious substances such as silane exhausted from reaction furnaces, etc.

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Description of Prior Art

Exhaust gases discharged from reaction furnaces in various plants such as semiconductor production plants contain deleterious substances which are highly toxic and likely to cause pyrophoric danger in contact with air, such as silane (SiH_4), disilane (Si_2H_6), phosphine (PH_3), arsine (AsH_3), germane (GeH_4), ammonia (NH_3), hydrogen selenide (H_2Se), hydrogen sulfide (H_2S).

Accordingly there exist legal requirements that such exhaust gases be disposed of only in concentrations lower than a predetermined allowable safety level. For disposing of exhaust gases of this type, there is known a method of diluting the exhaust gases with a nitrogen gas and scrubbing and decomposing them in a scrubber before releasing them externally. However, since the decomposition of the deleterious substances is insufficient in this method, the toxicity or pyrophoric property of the gases can not completely be eliminated.

In view of the above, there has also been employed a method of introducing a nozzle for discharging the exhaust gases to a burner and burning the exhaust gases jetted out from the nozzle by reaction with air within the burner. However, this method involves problems with oxidation decomposing products formed upon combustion are deposited on the top end of the exhaust gas nozzle to cause clogging, or the oxidation products deposited at the top end of the nozzle collapse and accumulate in the inside of the burner chamber.

As an attempt to counter the foregoing problems, US-A-4,555,389 discloses a method of supplying an inert gas such as a nitrogen gas near the top end of the exhaust gas nozzle thereby forming an inert gas atmosphere, and burning the exhaust gases ahead of this atmosphere, thereby preventing the deposition of combustion oxides at the top end of the nozzle. Although such a method is extremely useful for preventing the oxides from depositing on the top end of the nozzle and for improving the combustion efficiency and the durability, it involves the problems that the decomposition rate upon combustion of deleterious substances such as silane at a low concentration region is low and no substantial effect can be expected depending on the kind of the deleterious ingredients in the exhaust gases.

SUMMARY OF THE INVENTION

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Accordingly, it is an object of the present invention to provide a combustion method for exhaust gases capable of preventing the deposition of oxides at the top end of an exhaust gas nozzle and capable of maintaining a high decomposition rate upon combustion even when the concentration of the noxious deleterious substances is low.

Another object of the present invention is to provide a combustion method for exhaust gases capable of attaining the above-mentioned purpose for exhaust gases containing a wide range of deleterious substances such as silane, disilane, phosphine, arsine, germane, ammonia, hydrogen selenide, hydrogen sulfide.

The above objects are met accordingly to the present invention by a method for combustion of specific exhaust gases containing deleterious substances in which specific exhaust gases containing deleterious substances discharged from a reaction furnace, etc. are burnt by reaction with air upon emerging from a nozzle in a combustion chamber and then receive after treatment by means of a scrubber, bag filter, etc., characterised in that a combustible gas is supplied to and burnt around the top end of the nozzle for the exhaust gases, thereby forming a flame barrier of the combustible gases around the top end of said nozzle, and the exhaust gases are jetted into the flame barrier to be compulsorily burnt by said flame ahead of the barrier of the flame atmosphere.

The method of the invention is capable of maintaining a high decomposition rate upon combustion even when the concentration of the noxious substances is low and is also capable of preventing the deposition of oxides at the top end of the combustion nozzle.

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BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a longitudinal cross sectional view illustrating one embodiment of a device for practicing the combustion method for exhaust gases according to the present invention and,

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Figure 2 is an explanatory view for illustrating the way of practicing the conventional combustion method by a similar device.

DETAILED DESCRIPTION OF THE INVENTION

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Deleterious substance that are contained in specific exhaust gases discharged from reaction furnaces from various plants and which can be disposed of by combustion include for example silane (SiH_4), disilane (Si_2H_6), phosphine (PH_3), arsine (AsH_3), germane (GeH_4), ammonia (NH_3), hydrogen selenide (H_2Se) and hydrogen sulfide (H_2S).

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The present inventors have made an earnest study of methods of burning the specific exhaust gases containing these deleterious substances by reaction with air in a combustion chamber and then applying after treatment in a scrubber, a bag filter, etc., to solve the problem of the deposition of oxides on an exhaust gas nozzle and, in addition, to dispose of these substances at a high rate of decomposition upon combustion over a range of various deleterious substances irrespective of their concentration.

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As a result, it has been found that when a combustible gas such as a propane gas, natural gas or hydrogen is supplied around the top end of an exhaust gas nozzle and is burnt to constitute a flame barrier or curtain of the combustible gas around the top end of the exhaust gas nozzle and then the exhaust gases are jetted into the flame barrier, combustion of the deleterious substances of the exhaust gases does not take place in the flame barrier but the exhaust gases are compelled by the flame to react with air and burn ahead of, that is, at the outside of the flame barrier, whereby the combustion efficiency can be kept at an extremely high ratio at and from the low concentration region through a high concentration region of the deleterious substance.

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Specifically, the flame barrier of the combustible gas formed around the top end of the exhaust gas nozzle consumes oxygen upon combustion around the top end of the nozzle to suppress the combustion of the exhaust gases at the top end of the nozzle, as well as to heat the exhaust gases as they pass through the flame barrier and burns the gases discharged ahead of the flame barrier, i.e., into air.

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As described above, the flame barrier in the present invention can provide both the effect of preventing the combustion of the exhaust gases at the top end of the nozzle and the effect of forcibly burning the exhaust gases ahead of the flame barrier, which can both prevent the deposition of oxides at the top end of the exhaust gas nozzle and provide improvements in the combustion efficiency.

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The specific exhaust gases containing deleterious substances may, preferably, be mixed with inert gas such as a nitrogen gas and previously diluted to a desired concentration before combustion treatment.

Explanation will be made of the method according to the present invention while referring to a specific manner in which it is practiced by using a combustion device as illustrated in Figure 1.

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The combustion device comprises a vertical cylindrical body 4 closed at the upper and the lower ends thereof by an upper member 2 having a discharge port 1 and a lower plate 3 respectively. The cylindrical body 4 is vertically partitioned at the intermediate its ends with a perforated plate 5 to constitute a combustion cylinder having a combustion chamber 6 in the upper portion and an air chamber 7 in the lower portion.

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The air chamber 7 is connected with an air supply pipe 9 having a solenoid valve 8. The air chamber 7 formed below the combustion chamber 6 is in communication with the combustion chamber 6 by way of apertures 19 in the perforated plate 5 thereby constituting an air supply section to the combustion chamber 6. An exhaust gas introduction pipe 11 is inserted from below the air chamber 7 in the axial direction of the cylindrical body 4 and the pipe 11 is disposed such that it penetrates the lower plate 3 and the perforated plate 5 and a top end nozzle thereof protrudes inside of the combustion chamber 6. The rear end of the exhaust gas introduction pipe 11 is connected by way of an exhaust gas pipe 12 with a gas supply section 13 for receiving specific exhaust gases from a reaction furnace 14 that contains silane gas, etc. The exhaust gas introduction pipe 11 is also connected with an inert gas mixing pipe 15, such that an inert gas is mixed

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into the exhaust gases in the exhaust gas introduction pipe 11 to dilute the exhaust gases. Further, a flow rate controller 16 is disposed in the inert gas mixing pipe 15 so that the concentration and the flow rate of the exhaust gases jetted out from the top end nozzle of the exhaust gas introduction pipe 11 are controlled.

In a case where the boundary between the combustion chamber 6 and the air chamber 7 is constituted only by the perforated plate 5, it may cause the localization of air flow from the air chamber 7 to the combustion chamber 6 to a specific position, or may cause a backfire danger in which the flame in the combustion chamber 6 enters into the air chamber 7. In view of the above, it is desirable that a porous filler layer 17 made of non-combustible but air-permeable material of an appropriate thickness is applied to the lower surface of the perforated plate 5. In this case, a metal gage or a lattice-like support member 18 is fitted to the lower surface of the filler layer 17 so that the filler does not fall. Further, an outer pipe 19 is provided passing through the lower plate 3 and the perforated plate 5 of the air chamber 7 in the same manner as the exhaust gas introduction pipe 11 and spaced from the outer periphery of the exhaust gas introduction pipe 11 substantially in a coaxial manner to constitute a double-walled tubular combustion nozzle 20. A pipe 22 connected with a source 21 of combustible gas such as propane, natural gas or hydrogen is connected to the rear end of the outer pipe 19 by way of a flow rate controller 23 such that the flow rate and the flow speed of the combustible gas jetted out from the top end of the nozzle of the outer pipe 19 may be controlled.

A view window 26 is disposed in the combustion chamber 6 so that the state of the inside, particularly state of the flame generated above the nozzle of the exhaust gas introduction pipe 11 and the outer pipe 19, can be observed. In addition, a pressure gauge 25 is fitted to the combustion chamber 6.

Although one double-walled tubular combustion nozzle 20 comprising the exhaust gas introduction pipe 11 and the outer pipe 19 is used in this example, a plurality of such combustion nozzles may be used. An automatic ignition device 28 is preferably disposed near the upper jetting portion 27 of the double-walled tubular combustion nozzle 20 for the combustion of the combustible gases supplied from the outer tube 19.

In the embodiment illustrated in Figure 1 as described above, the combustible gas is supplied from the outer pipe 19 and burnt by the nozzle of the outer pipe 19 to form a flame barrier composed of the combustible gas around the top end of the nozzle of the exhaust gas introduction pipe 11. At the same time, exhaust gas containing deleterious substances such as silane, etc. sent from the reaction furnace are supplied, after dilution, by way of the exhaust gas introduction pipe 11 and jetted out from the top end nozzle thereof passing through the inside of the flame barrier into the combustion chamber 6. The exhaust gases pass through the flame barrier without combustion since the periphery around the top end of the nozzle of the exhaust gas introduction pipe 11 is surrounded with the flame barrier of the combustible gas and oxygen required for the combustion of the exhaust gases is insufficient there and also due to the effect of the flow rate of the flame.

When the exhaust gases are discharged ahead of the flame barrier, they are burnt by reaction with air in the combustion chamber; the exhaust gases are completely burnt ahead of the flame barrier due to the heating undergone upon passing through the flame barrier and compulsory combustion effect, by the flame itself from behind.

Comparative Example for Silane Combustion Treatment

Figure 2 shows the combustion method as disclosed in US-A-4,555,389 for the combustion of exhaust gases, by using the combustion device shown in Figure 1. In this case, an inert gas barrier is formed at the top end of a double-walled tubular combustion nozzle 20 by supplying an inert gas (for example, nitrogen) from an outer pipe 19 and, at the same time, diluted silane-containing exhaust gases are supplied in the same manner as the present invention from an exhaust gas introduction pipe 11, passed through the inside of and burnt ahead of the inert gas barrier.

Combustion processing data for the silane-containing exhaust gases are shown below in comparison between the present invention and conventional examples.

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Concentration of silane supplied (%)	Silane combustion rate (%)	
	A	B
0.16	-	100
0.33	0	100
0.99	31	100
1.64	88	100
2.28	97	-
2.91	99	-
*note:	A ... conventional example forming inert gas curtain (nitrogen gas) B ... example of the present invention in which flame curtain of the combustible gas is formed according to the present invention	
Condition:	**flow rate of silane-containing exhaust gases supplied ... 3 litre/min **combustion ratio, calculated by analysing the silane concentration after the processing by a gas chromatography equipped with photoionization detector.	

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From the above table, it can be seen that when using the prior art inert gas curtain (nitrogen), silane is not burnt at all if the silane concentration is less than 0.33%, and the combustion ratio of silane can not attain 100% even at a silane concentration as high as 2.9%. On the other hand, complete combustion takes place according to the present invention even if the silane concentration is as low as 0.16% in exhaust gases.

As has been described above in accordance with the present invention, deposition of oxides to the top end of the nozzle can be avoided and, in addition, various deleterious substances in exhaust gases can completely be burnt even at a low concentration.

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Furthermore, since the flame barrier can provide both the effect of preventing the deposition of oxides and the effect of improving the combustion ratio, the structure of the device is not complicated and the existing device used for the conventional method can be utilized as it is.

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Claims

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1. A method for combustion of specific exhaust gases containing deleterious substances in which specific exhaust gases containing deleterious substances discharged from a reaction furnace, etc. are burnt by reaction with air upon emerging from a nozzle in a combustion chamber and then receive after treatment by means of a scrubber, bag filter, etc., characterised in that a combustible gas is supplied to and burnt around the top end of the nozzle for the exhaust gases, thereby forming a flame barrier of the combustible gases around the top end of said nozzle, and the exhaust gases are jetted into the flame barrier to be compulsorily burnt by said flame ahead of the barrier of the flame atmosphere.

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2. A method according to Claim 1, wherein the exhaust gases are diluted by admixture with an inert gas prior to discharge from the nozzle.

FIG. 1

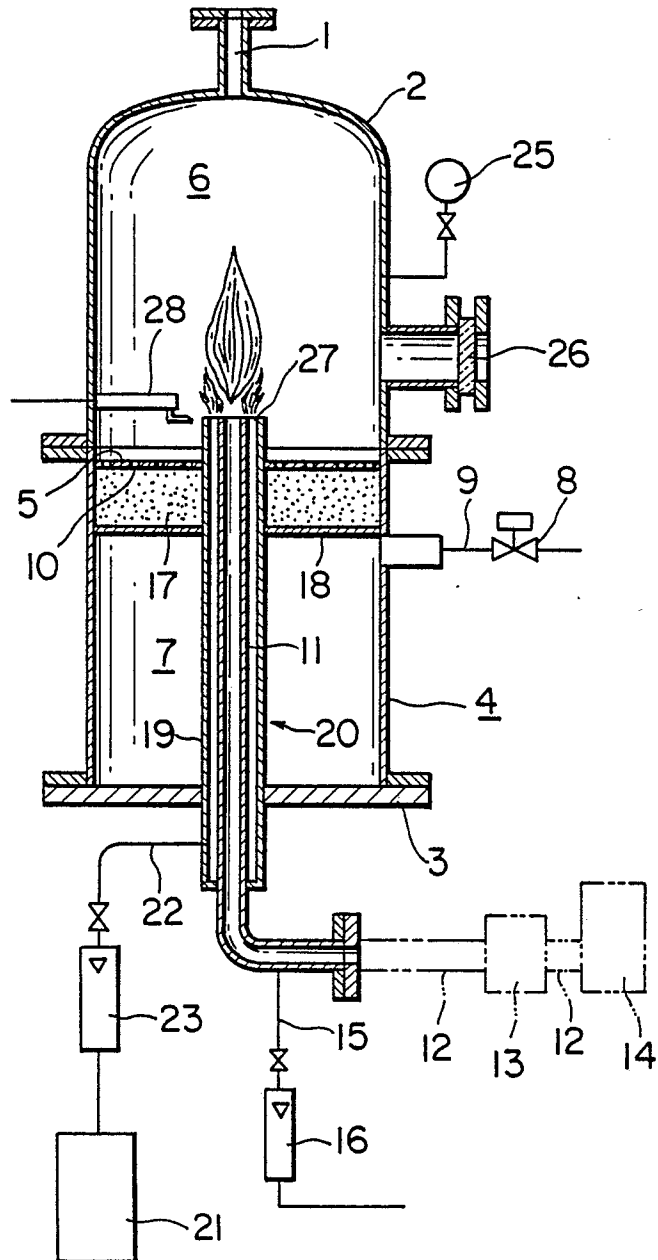


FIG. 2

