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COMPOSITE GAS TREATMENT SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a gas treatment system for scrubbing a gaseous effluent produced in chemical factories or the like prior to discharge into the ambient environment, and more particularly to a composite gas treatment system for burning toxic gaseous effluents produced in a semiconductor fabrication process by fuel obtained in accordance with an electrolysis, removing particulates from the burned effluents, and discharging the resultant matter into the ambient environment.

Description of the Prior Art

Generally, gaseous effluents are produced in a large quantity in a semiconductor fabrication process involving, for example, diffusion, chemical vapor deposition, and etching. Such gaseous effluents should be subjected to an appropriate scrubbing process prior to discharge into the ambient environment because they are highly toxic, explosive, and corrosive. Typically, these gaseous effluents include SiH_4, Cl_2, NH_3, AsH_3, PH_3, B_2H_6, and GeH_4 and are laden with particulates such as silica particles. In order to prevent a

gaseous effluent from polluting the environment, it is necessary to decrease the concentrations of components of the gaseous effluent to an allowable level.

Conventionally, scrubbers of various types, such as a wet type, a combustion type, a wet and combustion type, namely, a combination type, an absorption type, and a catalyst type, have been mainly used. An example of a wet type scrubber is disclosed in U.S. Patent No. 5,011,520 issued on April 30, 1991. As disclosed in U.S. Patent No. 5,011,520, the wet type scrubber is adapted to spray a scrubbing liquid onto a gaseous effluent laden with particulates, thereby removing toxic components from the gaseous effluent. This wet type scrubber has advantages in that it has a large treating capacity while involving low operating costs and that it can treat halogen gas. However, the scrubber has a low treating efficiency and involves a possibility of blocking of a gas inlet thereof after operating for an extended period of time. A combustion type scrubber is adapted to burn a gas effluent using a heater, thereby achieving a decomposition and oxidation of the gas effluent. Although this combustion type scrubber can efficiently treat flammable gaseous effluents, it has drawbacks in that there is a difficulty in handling by-products and that it cannot burn halogen gas. On the other hand, a combination type scrubber is known as being capable of efficiently treating most kinds of gaseous effluents including

halogen gas with relatively low operating costs.

However, such a combination type scrubber also has various drawbacks. That is, the combination type scrubber should be provided with a plurality of burners adapted to operate different temperatures in order to burn different kinds of gaseous effluents, respectively. For this reason, the combination type scrubber involves high manufacturing costs while requiring a large installation space. A heater, which is equipped in conventional combination type scrubbers, may be subjected, after a certain period of operating time, to a heat fade phenomenon resulting in a degradation in performance. Furthermore, the heat fade phenomenon causes a limitation in increasing a combustion temperature. For this reason, it is difficult to completely burn gaseous effluents being flammable at a high temperature. In order to solve this problem, a proposal may be made in which fuel from an external supply source is supplied to the interior of the heater and additionally burned in addition to an operation of the heater so as to achieve an increase in combustion temperature. In this case, however, the fuel supply line used is complex. Moreover, there is a possibility of explosion accidents caused by leakage of fuel.

SUMMARY OF THE INVENTION

The present invention has been made in view of the above mentioned problems involved in the prior art, and an object of the invention is to provide a composite gas treatment system having a compact configuration capable of separately receiving a low temperature flammable gaseous effluent and a high temperature flammable gaseous effluent in order to allow those gas effluents to be burned at different temperatures, respectively.

Another object of the invention is to provide a composite gas treatment system having a configuration capable of burning high temperature flammable gaseous effluents using fuel produced in the system, thereby simplifying the fuel supply line used while minimizing a possibility of explosion accidents caused by leakage of fuel.

In accordance with the present invention, these objects are accomplished by providing a composite gas treatment system for scrubbing low and high temperature flammable gaseous effluents produced in a chemical process, and discharging the scrubbed gaseous effluents into the ambient environment comprising: a stand-alone housing having an upper compartment and a lower compartment; a low temperature burner disposed in the upper compartment of the housing and adapted to receive the low temperature flammable gaseous effluent, to thermally

decompose the received low temperature flammable gaseous effluent at a first temperature, and then to discharge the resultant gas, produced after the thermal decomposition, into the ambient environment; a high temperature burner disposed in the upper compartment of the housing in parallel to the low temperature burner and adapted to receive the high temperature flammable gaseous effluent, to thermally decompose the received high temperature flammable gaseous effluent at a second temperature higher than the first temperature, and then to discharge the resultant gas, produced after the thermal decomposition, into the ambient environment; and a fuel gas producing unit disposed in the lower compartment of the housing and adapted to spontaneously produce fuel gas and to supply the produced fuel gas to the high temperature burner.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and aspects of the invention will become apparent from the following description of embodiments with reference to the accompanying drawings in which:

FIG. 1 is a partially-broken front view illustrating a composite gas treatment system according to a preferred embodiment of the present invention;

FIG. 2 is a partially-broken enlarged view best illustrating a low temperature burner, a dust collector, and

a low temperature exhaust pipe included in the composite gas treatment system of FIG. 1;

FIG. 3 is a partially-broken enlarged view best illustrating a high temperature burner, a wet type scrubber, and a high temperature exhaust pipe included in the composite gas treatment system of FIG. 1;

FIG. 4 is a partially-exploded perspective view illustrating an electrolyzer including a plurality of plate electrodes; and

FIG. 5 is a block diagram of a fuel gas producing unit connected to the high temperature burner.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a composite gas treatment system according to the present invention includes a stand-alone housing 10 divided into an upper compartment 12 and a lower compartment 14. Casters 16 are attached to the bottom of the housing 10 in order to allow the gas treatment system to be easily moved to a desired place. A low temperature burner 18 is vertically arranged in the upper compartment 12 of the housing 10. The low temperature burner 18 serves to receive a low temperature flammable gaseous effluent produced in a chemical process, for example, a semiconductor fabrication process, and to burn the received gaseous effluent. The low

temperature flammable gaseous effluent may include SiH_4, SiH_2Cl_2, NH_3, WF_6, PH_3, or B_2H_6 even though it is not limited to these matters.

As best shown in FIG. 3, the low temperature burner 18 includes a generally cylindrical casing 20 defined with a coolant passage therein. The casing 20 is provided with a central combustion chamber 20a, upper inlets 20b and a lower outlet 20c. A cylindrical heater element 22, which serves to convert electrical energy to thermal energy, is coaxially arranged in the interior of the casing 20 in such a fashion that it extends along the length of the casing 20. An insulator 24 is arranged around the heater element 22 to inhibit heat from the heater element 22 from emitting outwardly of the casing 20. The heater element 22 is coated at the inner surface thereof with a liner 26 exhibiting a high heat resistance and a high corrosion resistance. The liner 26 may be made of ceramic or nickel alloy. This liner 26 serves to absorb thermal energy from the heater element 22, so that it is rendered to be in a glow state in which it thermally decomposes or oxidizes a low temperature flammable gaseous effluent passing though the central combustion chamber 20a of the casing 20. The heater element 22 is controlled to maintain the central combustion chamber 20a at a temperature of about 750°C.

A dust collector 28 is disposed at the outlet 20c of the

casing 20 in the low temperature burner 18. The dust collector 28 is adapted to collect particulates laden in thermally-decomposed gas discharged from the low temperature burner 18 and to remove the collected particulates. The dust collector 28 is provided with a hopper 30 connected to the central combustion chamber 20a of the low temperature burner 18 via a connecting pipe 32. A fan 34 is connected to the connecting pipe 32 via an air tube 36. The fan 34 blows air into the hopper 30, thereby causing a cyclone air flow to be generated in the hopper 30. By virtue of the cyclone air flow, particulates laden in the thermally decomposed gas introduced into the hopper 30 are forced to fall down toward the lower end of the hopper 30. At the lower end of the hopper 30, a collection tank 38 is arranged which serves to collect the falling particulates. The particulates collected in the collection tank 38 are then fed to a temporary storage tank 42 by a feeding mechanism 40. The particulates from the temporary storage tank 42 are outwardly discharged for removal thereof.

A vertical low temperature exhaust pipe 44 is connected to the upper end of the hopper 30. The low temperature exhaust pipe 44 extends into the hopper 30 by a desired length at the lower end thereof in order to prevent particulates laden in the thermally decomposed gas entering the hopper 30 from being directly introduced into the low temperature

exhaust pipe 44. In the low temperature exhaust pipe 44, a filter 46 is disposed which serves to filter the thermally decomposed gas prior to discharge into the ambient environment.

Referring to FIG. 1 again, it can be found that a high temperature burner 48 is arranged in parallel to the low temperature burner 18 in the upper compartment 12 of the housing 10. The high temperature burner 48 has a configuration suitable to receive a high temperature flammable gaseous effluent produced in, for example, a semiconductor fabrication process, and to burn the received gaseous effluent. The high temperature flammable gaseous effluent may include NF_3, CF_4, C_2F_6, SF_6, CHF_3, or C_4F_8 even though it is not limited to these matters.

As best shown in FIG. 3, the high temperature burner 48 includes a generally cylindrical casing 50 defined with a coolant passage therein. The casing 50 is provided with a central combustion chamber 50a, upper inlets 50b and a lower outlet 50c. A cylindrical heater element 52, which serves to convert electrical energy to thermal energy, is coaxially arranged in the interior of the casing 50 in such a fashion that it extends along the length of the casing 50. An insulator 54 is arranged around the heater element 52 to inhibit heat from the heater element 52 from emitting outwardly of the casing 50. The heater element 52 is coated

at the inner surface thereof with a liner 56 exhibiting a high heat resistance and a high corrosion resistance. The liner 56 may be made of ceramic or nickel alloy. This liner 26 serves to absorb thermal energy from the heater element 52, so that it is rendered to be in a glow state in which it maintains the central combustion chamber 20a at an increased temperature of about 750°C.

A fuel injection nozzle 58 is arranged at the upper end of the high temperature burner 48 in such a fashion that it can downwardly inject fuel in the central combustion chamber 50a. As shown in FIGS. 1 and 5, the fuel injection nozzle 58 is supplied with oxygen gas and hydrogen gas
from a fuel gas producing unit 60, disposed in the lower compartment 14 of the housing 10, via a fuel supply pipe 62. Hydrogen gas injected from the fuel injection nozzle 58 flames spontaneously at about 580°C. In accordance with the burning of the hydrogen gas, the internal temperature of the central combustion chamber 50a in the high temperature burner 48 increases to about 1,200°C, thereby allowing high temperature flammable gaseous effluent introduced into the high temperature burner 48 to be efficiently thermally decomposed or oxidized. In the embodiment of the present invention illustrated in FIG. 1, the fuel injection nozzle 58 is connected with an air compressor 64 so that it is supplied with compressed air from the air compressor 64 to supply it to

the central combustion chamber 50a.

A wet type scrubber 66 is disposed at the lower outlet 50c of the casing 50 in the high temperature burner 48. The wet type scrubber 66 is adapted to cool and neutralize thermally-decomposed gas discharged from the high temperature burner 48 while removing soluble matters and particulates laden in the thermally-decomposed gas. As best shown in FIG. 3, the wet type scrubber 66 includes a scrubbing container 68 adapted to receive the thermally-decomposed gas from the high temperature burner 48 and to allow the thermally-decomposed gas to come into contact with water, a water reservoir 70 adapted to store water overflowing the scrubbing container 68, and a water recycling pipe 74 adapted to upwardly suck the water from the water reservoir 70, thereby injecting the sucked water into the scrubbing container 68. The water recycling pipe 74 is provided with a water injection nozzle 76 protruded into the interior of the scrubbing container 68. The water injection nozzle 76 is arranged just beneath the outlet 50c of the high temperature burner 48 so as to inject the water contained in the water reservoir 70 into the scrubbing container 68 in accordance with a Venturi effect. The scrubbing container 68 is supplied with water from an external supply source via a water supply pipe 78. Water from the water reservoir 70 is outwardly discharged through a discharge pipe 80. The scrubbing container 68 and water

reservoir 70 are made of stainless steel having a superior corrosion resistance. Preferably, the scrubbing container 68 and water reservoir 70 are coated with a Teflon film at their inner surfaces.

A neutralizer supplier 82 is connected to the scrubbing container 68 in order to neutralize the water contained in the scrubbing container 68, thereby maintaining a desired pH of the water. The neutralizer supplier 82 is stored with, for example, potassium hydroxide. In response to an output signal from a pH sensor 84 disposed in the water reservoir 70, the neutralizer supplier 82 is operated by a drive unit (not shown), thereby supplying an appropriate amount of potassium hydroxide to the scrubbing container 68. Bubble generators 86 are disposed at respective bottoms of the scrubbing container 68 and water reservoir 70. The bubble generators 86 generate a large quantity of bubbles while receiving compressed air from an air compressor 88 in order to prevent a deposition of particulates on respective bottoms of the associated scrubbing container 68 and water reservoir 70 while enhancing the scrubbing efficiency for the thermally-decomposed gas. A vertical high temperature exhaust pipe 90 is connected to the top of the scrubbing container 68 and arranged in parallel to the high temperature burner 48. The high temperature exhaust pipe 90 serves to discharge the scrubbed gas from the scrubbing container 68 into the ambient environment. In the

high temperature exhaust pipe 44, a filter 92 is disposed which serves to filter moisture and particulates laden in the exhaust gas passing through the high temperature exhaust pipe 90. As shown in FIG. 1, the high temperature exhaust pipe 90 is joined with the low temperature exhaust pipe 44 at the upper end thereof. A common exhaust duct 94 is connected to the joined portion of the pipes 44 and 90, so that exhaust gas emerging from those pipes 44 and 90 is discharged into the ambient environment through the common exhaust duct 94.

Referring to FIGS. 1, 4, and 5, the fuel gas producing unit 60, which serves to supply fuel gas to the fuel injection nozzle 58, includes electrolyzers 96 each adapted to electrolyze water, thereby producing oxygen gas and hydrogen gas. Each electrolyzer 96 is supplied with water from a water tank 98 which is connected to a feedback tank 102 via a water pump 100. Accordingly, water from a water supply source 104 introduced into the feedback tank 102 is pumped to the water tank 98 by an operation of the water pump 100, and then fed to the electrolyzer 96. The water pump 100 also supplies the water from the feedback tank 102 to a reverse-flaming prevention tank 106. Water overflowing the reverse-flaming prevention tank 106 is returned to the feedback tank 102. The water-filled reverse-flaming prevention tank 106 has a lower inlet 106a and an upper outlet 106b. Accordingly, the oxygen gas and hydrogen gas produced from each electrolyzer 96 are

introduced into the reverse-flaming prevention tank 106 though the lower inlet 106a, and then discharged from the reverse-flaming prevention tank 106 through the upper outlet 106b while passing through the water contained in the reverse-flaming prevention tank 106. Thus, the reverse-flaming prevention tank 106 prevents explosion accidents caused by a propagation of flames from the fuel injection nozzle 58 to the electrolyzer 96 via the fuel supply pipe 62.

As shown in FIG. 4, each electrolyzer 96 includes a plurality of plate electrodes 108 integrally coupled by bolts 110. Each of the plate electrodes 108 is electrically connected to a power supply not shown. Each plate electrode 108 is formed with a water introduction hole 108a and a gas discharge hole 108b. The water introduction hole 108a communicates with the water tank 98 shown in FIGS. 1 and 5 whereas the gas discharge hole 108b communicates with the reverse-flaming prevention tank 106. An insulating gasket 112 having a considerable thickness and a seal ring 114 are interposed between adjacent plate electrodes 108 in order to provide a space for receiving water in an amount required for an electrolysis between those plate electrodes 108. When current flows through the electrolyzer 96, the plate electrodes 108 of the electrolyzer 96 electrolyze water present between adjacent ones thereof, thereby producing oxygen gas and hydrogen gas. The produced oxygen gas and

hydrogen gas are discharged from the electrolyzer 96 through the gas discharge holes 108b of the plate electrodes 108, and then supplied to the fuel injection nozzle 58 of the high temperature burner 48 via the reverse-flaming prevention tank 106. Although the fuel gas producing unit 60 is equipped with two electrolyzers 96 in the embodiment illustrated in FIG. 1, it may use an increased or decreased number of electrolyzers 96 in accordance with the amount of fuel gas required in the high temperature burner 48.

Now, the operation of the composite gas treatment system having the above mentioned configuration according to the present invention will be described. First, a low temperature flammable gaseous effluent producing in, for example, a semiconductor fabrication process, is introduced into the central combustion chamber 20a of the low temperature burner 18. In the central combustion chamber 20a, the gaseous effluent is thermally decomposed by heat of about 750°C generated from the heater element 22. The thermally decomposed gas is then sent to the hopper 30 of the dust collector 28 via the connecting pipe 32. At this time, the fan 34 blows air into the hopper 30, thereby generating a cyclone air flow. By virtue of the cyclone air flow, particulates laden in the thermally decomposed gas introduced in the hopper 30 are forced to fall down toward the lower end of the hopper 30, so that they are collected in the collection

tank 38. The particulates collected in the collection tank 38 are fed to the temporary storage tank 42 by an operation of the feeding mechanism 40, and then outwardly discharged from the temporary storage tank 42 for removal and disposal thereof.

Meanwhile, the thermally decomposed gas passing through the hopper 30 of the dust collector 28 flames spontaneously while being mixed with air supplied from the fan 34. In other words, the thermally decomposed gas, which is in a heated state upon emerging from the low temperature burner 18, generates an oxidation while being mixed with air, so that it flames spontaneously. As a result, the thermally decomposed gas is burned in the hopper 30, so that it is thermally decomposed again, thereby remarkably improving the processing efficiency thereof. The thermally decomposed gas emerging from the hopper 30 passes through the filter 46 of the low temperature exhaust pipe 44, and is then discharged into the ambient environment.

On the other hand, a high temperature flammable gaseous effluent is introduced into the central combustion chamber 50a of the high temperature burner 48. The heater element 52 of the high temperature burner 48 increases the temperature of the central combustion chamber 50a to about 750°C. In this state, accordingly, hydrogen gas, which is injected from the fuel injection nozzle 58 into the central combustion chamber

50a, flames spontaneously at about 580°C, so that it is burned. As a result, the temperature of the central combustion chamber 50a of the high temperature burner 48 increases to about 1,200°C. This results in an efficient thermal decomposition of the high temperature flammable gaseous effluent introduced in the central combustion chamber 50a. Fuel gas, that is, oxygen gas and hydrogen gas, are produced by the electrolyzers 96 of the fuel gas producing unit 60, and then supplied to the fuel injection nozzle 58 via the reverse-flaming prevention tank 106.

The thermally decomposed gas emerging from the central combustion chamber 50a of the high temperature burner 48 is introduced into the scrubbing container 68 of the wet type scrubber 66. At this time, the water injection nozzle 76 injects water into the scrubbing container 68 in accordance with a Venturi effect. The injected water is mixed with the thermally decomposed gas in the scrubbing container 68, thereby separating soluble matters and particulates, laden in the thermally decomposed gas, from the thermally decomposed gas while cooling the thermally decomposed gas. Water overflowing the scrubbing container 68 is returned to the water reservoir 70 so that it is supplied again to the scrubbing container 68 via the water recycling pipe 74. During the introduction of the thermally decomposed gas into the scrubbing container 68, the pH sensor 84 continuously

detects the pH of the water contained in the water reservoir 70. When the pH of the water contained in the water reservoir 70 is more than a predetermined reference value, the neutralizer supplier 82 operates, in response to a corresponding output signal from the pH sensor 84, to supply a neutralizer such as potassium hydroxide to the scrubbing container 68, thereby neutralizing the water. Meanwhile, the air compressor 88 supplies compressed air to the bubble generators 86 respectively disposed in the scrubbing container 68 and water reservoir 70 to allow a generation of bubbles from those bubble generators 86. Thus, it is possible to prevent a deposition of particulates on respective bottoms of the scrubbing container 68 and water reservoir 70 while enhancing the scrubbing efficiency for the thermally-decomposed gas. The scrubbed gas from the scrubbing container 68 of the wet type scrubber 66 is then discharged into the ambient environment after passing through the filter 92 of the high temperature exhaust pipe 90.

As apparent from the above description, the present invention provides a composite gas treatment system having a configuration capable of simultaneously burning both low and high temperature flammable gaseous effluents using a single unit while achieving the burning of the high temperature flammable gaseous effluent using fuel produced in the system. Accordingly, the composite gas treatment system of the present

invention provides excellent effects in that it is possible to simplify the fuel supply line used while preventing explosion accidents caused by leakage of fuel.

Although the preferred embodiments of the invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

WHAT IS CLAIMED IS:

1. A composite gas treatment system for scrubbing low and high temperature flammable gaseous effluents produced in a chemical process, and discharging the scrubbed gaseous effluents into the ambient environment, comprising:

a stand-alone housing having an upper compartment and a lower compartment;

a low temperature burner disposed in the upper compartment of the housing and adapted to receive the low temperature flammable gaseous effluent, to thermally decompose the received low temperature flammable gaseous effluent at a first temperature, and then to discharge the resultant gas, produced after the thermal decomposition, into the ambient environment;

a high temperature burner disposed in the upper compartment of the housing in parallel to the low temperature burner and adapted to receive the high temperature flammable gaseous effluent, to thermally decompose the received high temperature flammable gaseous effluent at a second temperature higher than the first temperature, and then to discharge the resultant gas, produced after the thermal decomposition, into the ambient environment; and

a fuel gas producing unit disposed in the lower compartment of the housing and adapted to spontaneously

produce fuel gas and to supply the produced fuel gas to the high temperature burner.

2. The composite gas treatment system according to claim 1, further comprising:

a dust collector arranged at an outlet of the low temperature burner and adapted to collect particulates laden in the thermally decomposed gas discharged from the low temperature burner and to remove the collected particulates.

3. The composite gas treatment system according to claim 1, further comprising:

a wet type scrubber arranged at an outlet of the high temperature burner and adapted to allow the thermally decomposed gas discharged from the high temperature burner to come into contact with moisture, thereby scrubbing the thermally decomposed gas.

4. The composite gas treatment system according to claim 1, wherein the high temperature burner comprises:

a cylindrical casing having a central combustion chamber, an inlet, and an outlet;

a cylindrical heater element coaxially arranged in the casing along the length of the casing; and

a fuel injection nozzle arranged at the inlet of the

casing in such a fashion that it injects the fuel gas into the central combustion chamber of the casing, the fuel injection nozzle being connected to the fuel gas producing unit.

5. The composite gas treatment system according to claim 4, wherein the fuel gas producing unit comprises at least one electrolyzer adapted to electrolyze water into oxygen gas and hydrogen gas and to supply the oxygen and hydrogen gas to the fuel injection nozzle of the high temperature burner via a reverse-flaming prevention tank contained with water.

6. The composite gas treatment system according to claim 5, wherein the reverse-flaming prevention tank has a lower inlet connected to the electrolyzer to receive the fuel gas from the electrolyzer, and an upper outlet connected to the fuel injection nozzle of the high temperature burner to supply the fuel gas to the fuel injection nozzle, whereby the fuel gas produced in the electrolyzer can be supplied to the fuel injection nozzle through the water contained in the reverse-flaming prevention tank.