

## FLAME-FREE CATALYTIC THERMAL OXIDATION INCINERATION DEVICE

### Technical Field

The present invention relates to a flame-free catalytic thermal oxidation incineration device, and more particularly, to a flame-free catalytic thermal oxidation incineration device that may be used to treat various environmentally harmful substances generated from an oil-refining facility, processes of manufacturing semiconductors and light-emitting diode (LED) displays, and the like.

### Background Art

Various technologies, for example, a regenerative oxidation method, a catalytic thermal oxidation method, and a flameless thermal oxidation method, may be used to treat environmentally harmful substances generated from an oil refining treatment process including a heavy oil refining treatment at an oil refinery and a process of manufacturing semiconductors and light-emitting diode (LED) displays and panels. The technologies may be used to completely decompose, by incinerating, the substances including ammonia generated during the processes into hydrogen and nitrogen and emit those gases harmless to environment.

The technologies may be used to completely combust the substances harmful to a human body, for example, toluene, benzene, ethylene, and ammonia, into carbon dioxide, water vapor, hydrogen, nitrogen, and the like that are harmless to the human body. For this purpose, it may be required that nitrogen compounds such as ammonia should not generate NO<sub>x</sub> during combustion. When NO<sub>x</sub> is generated, secondary air pollution may arise.

Among the foregoing technologies, the flameless thermal oxidation method may be applied to achieve a higher rate of complete combustion and a higher efficiency for fuel supply in comparison to the regenerative oxidation method and the catalytic thermal oxidation method.

However, an existing flame-free thermal oxidation incineration device to which the flameless thermal oxidation method is applied may not achieve a desirable result because such device may generate a few hundred parts per million (ppm) of concentration of the harmful substances such as NO<sub>x</sub> when flameless thermal oxidation incineration is performed by injecting a reactant including the harmful substances into an incinerating furnace of the device. Reasons for the undesirable result may include preheating the incinerating furnace without preheating the reactant, absence of a catalyst, and instable energy supply due to a high-temperature oxidation or deterioration of the heater of the device.

#### Disclosure of Invention

##### Technical Goal

An aspect of the present invention provides a flame-free catalytic thermal oxidation incineration device that may greatly reduce a concentration of harmful substances, for example, NO<sub>x</sub>, to be a few parts per million (ppm).

Another aspect of the present invention provides a flame-free catalytic thermal oxidation incineration device that may include a heater provided in a structure to prevent high-temperature oxidation and may be provided in a simple structure to be assembled and disassembled as a need arises.

##### Technical Solutions

According to an aspect of the present invention, there is provided a flame-free catalytic thermal incineration device including an incinerating furnace to be settled in a housing and equipped with air pores, a reactant inlet to allow a reactant to be combusted to flow into the incinerating furnace, a reactant heating and feeding unit to be extended downwards from the reactant inlet, embedded with a heater, and including an opening in its lower part, an oxygen feeding unit to feed oxygen through the air pores of the incinerating furnace, and a metallic oxide catalyst to fill in the

incinerating furnace.

The heater provided in the reactant heating and feeding unit may consist of heating wire and an electrical contact unit, wherein the electrical contact unit may be disposed in a lower portion of the heater, and the heating wire may be disposed to be extended upwards from the electrical contact unit.

A plurality of the air pores of the incinerating furnace may be formed on a floor surface of the incinerating furnace.

The oxygen feeding unit may be provided to lead to a surface of an inner wall of the housing of the incinerating furnace to allow oxygen to descend along the surface of the inner wall of the housing of the incinerating furnace and to be fed through the air pores on the floor surface of the incinerating furnace.

The oxygen feeding unit may include a hollow disc to be disposed surrounding the reactant inlet, a first pipe to be in contact with an end of the disc and lead to the disc, and allow oxygen to flow into the disc, and a second pipe to be in contact with another end of the disc and lead to the disc, and feed oxygen escaping from the disc to the surface of the inner wall of the housing of the incinerating furnace.

The opening to be formed in the lower portion of the reactant heating and feeding unit may include a plurality of air pores.

The heater may be heated up to approximately 800°C through 1200°C.

The metallic oxide catalyst may include  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Fe}_2\text{O}_3$ , and  $\text{MnO}_x$ .

The housing of the incinerating furnace may include a protruded fixing unit at both ends to allow an entirety of the housing to rotate on the protruded fixing unit.

### Effects of Invention

According to exemplary embodiments of the present invention, a metallic oxide catalyst may be added to incinerate harmful substances using a flameless thermal oxidation method. Accordingly, an expeditious and complete combustion

85 may occur and a concentration of the harmful substances, for example, NO<sub>x</sub>, may be reduced to a few ppm.

According to exemplary embodiments of the present invention, a reactant inlet through which harmful substances descend from top to bottom may be heated by a heater provided in a reactant heating and feeding unit and connected to the reactant  
90 inlet. Accordingly, a reactant may be preheated and combusted completely and expeditiously.

According to exemplary embodiments of the present invention, an electrical contact unit of a heater provided in a reactant heating and feeding unit may be disposed in a lower portion of an incinerating furnace and heating wire may be  
95 disposed to face upwards, in consideration of a rise of a heated air current. Accordingly, a life of a flame-free catalytic thermal oxidation incineration device may be extended by preventing damage to the electrical contact unit that may be caused by high-temperature oxidation.

According to exemplary embodiments of the present invention, oxygen may  
100 pass through a disc surrounding a reactant inlet, descend along a surface of an inner wall of a housing of an incinerating furnace, and be fed through air pores on a floor surface of the incinerating furnace. Accordingly, heat exchange may be enabled through the oxygen feeding channel and a thermal effect of maintaining a heat of the incinerating furnace may be improved.

105 According to exemplary embodiments of the present invention, a housing of an incinerating furnace may include a protruded fixing unit to allow an entirety of the housing to rotate on the protruded fixing unit. Accordingly, convenience in replacing components or in assembling and disassembling the components for breakdown repair may be improved.

#### Brief Description of Drawings

110 FIG. 1 is a perspective view illustrating an overall exterior of a flame-free

catalytic thermal oxidation incineration device according to an embodiment of the present invention.

115        FIG. 2 is a schematic cross-sectional view of the flame-free catalytic thermal oxidation incineration device of FIG. 1 for illustrating an operation of main components according to an embodiment of the present invention.

         FIG. 3 is a perspective cut view of an internal configuration of an incinerating furnace of the flame-free catalytic thermal oxidation incineration device of FIG. 1  
120        according to an embodiment of the present invention.

         FIG. 4 is a cross-sectional chart of an oxygen feeding unit illustrating an oxygen feeding channel according to an embodiment of the present invention.

         FIG. 5 is an exploded perspective view of a reactant heating and feeding unit illustrating a configuration of a heater included in a flame-free catalytic thermal  
125        oxidation incineration device according to an embodiment of the present invention.

         FIG. 6 is a planar view of a floor surface of an incinerating furnace according to an embodiment of the present invention.

         FIG. 7 is a cross-sectional view illustrating an example in which an entirety of a housing of an incinerating furnace rotates on a protruded fixing unit provided in the  
130        housing of the incinerating furnace according to an embodiment of the present invention.

         FIG. 8 are perspective views illustrating a housing of an incinerating furnace and an example in which the housing of the incinerating furnace rotated by the operation illustrated in FIG. 7 according to an embodiment of the present invention.

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[Reference Numerals of Drawings]

1000: Flame-free catalytic thermal oxidation incineration device

100: Housing

101: Incinerating furnace

140        110: Reactant inlet

120: Oxygen feeding unit

121: First pipe

123: Disc

125: Second pipe

145 127: Gap

129, 139: Air pores

135: Heater

136: Heating wire

137: Electrical contact unit

150 160: Protruded fixing unit

200: Heat exchanger

### Best Mode for Carrying Out Invention

Reference will now be made in detail to embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below in order to explain the present invention by referring to the figures.

FIG. 1 is a perspective view illustrating an overall exterior of a flame-free catalytic thermal oxidation incineration device 1000 according to an embodiment of the present invention. FIG. 1 illustrates a housing 100 in which an incinerating furnace 101 is disposed, and a heat exchanger 200 that cools and emits a product of combustion generated from the incinerating furnace 101 and is connected to the incinerating furnace 101.

The device 1000 may schematically operate as follows.

165 A reactant including harmful substances may flow into the incinerating furnace 101 through a reactant inlet 110 disposed in an upper portion of the housing 100. In the meantime, air including oxygen may be supplied to the incinerating furnace 101 through a separate channel. After the reactant is combusted at a high

temperature and at a high efficiency due to a metallic oxide catalyst added to the  
170 incinerating furnace 101, the product of the combustion may enter the heat  
exchanger 200 through an outlet, pass through the heat exchanger 200, and be  
emitted outside by being liquefied or cooled down to be in a state of gas.

A detailed configuration and operation of the foregoing components will be  
further described with reference to FIGS. 2 and 3.

175 FIG. 2 is a schematic cross-sectional view of the flame-free catalytic thermal  
oxidation incineration device 1000 of FIG. 1 for illustrating an operation of main  
components. FIG. 3 is a perspective cut view of an internal configuration obtained  
by cutting a portion of the housing 100.

The incinerating furnace 101 may be assembled inside the housing 100 to  
180 have a gap from a surface of an inner wall of the housing 100. The reactant inlet  
110 through which a reactant including harmful substances flows into the incinerating  
furnace 101 may be disposed in an upper portion of the housing 100. The reactant  
entering the incinerating furnace 101 through the reactant inlet 110 may flow into a  
lower portion of the incinerating furnace 101 through a reactant heating and feeding  
185 unit 130 connected to the reactant inlet 110.

The reactant heating and feeding unit 130 may be provided in a form of a  
chimney and include a heater 135. The heater 135 may include heating wire that  
may desirably spread up to approximately  $1/2$  through  $2/3$  of a total height of the  
reactant heating and feeding unit 130 provided in the form of the chimney. In virtue  
190 of an operation of the heater 135, the reactant entering through the reactant inlet 110  
may be preheated before descending to a lower portion of the incinerating furnace  
101 and thus, allowing the reactant to be easily and completely combusted. A lower  
portion of the reactant heating and feeding unit 130 may include an opening to  
discharge the reactant to an interior of the incinerating furnace 101, and more  
195 desirably to discharge the reactant through a plurality of air pores 139 as illustrated  
in FIG. 3.

Also, the interior of the incinerating furnace 101 may be filled with a catalyst 150 to facilitate complete combustion. The catalyst 150 may include at least one substance selected from a group of metallic oxides, for example,  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Fe}_2\text{O}_3$ , and  $\text{MnO}_x$ .

Oxygen required to combust the reactant may be fed through air pores 129 formed on a floor surface of the incinerating furnace 101. A channel of an oxygen feeding unit 120 through which the oxygen is fed will be described hereinafter.

The oxygen may be fed, through a first pipe 121, to a hollow disc 123 assembled to surround the reactant inlet 110 from an air container (now shown) disposed outside of the incinerating furnace 101 and containing oxygen. The disc 123 may be provided in plural and concentrically piled up one on another. The disc 123 and the first pipe 121 may be connected to each other with a nozzle into which oxygen flows. Thus, the injected oxygen may fill in the disc 123 and absorb a portion of a heat supplied by the heater 135. Also, the injected oxygen may move to a second pipe 125 connected to another end of the disc 123. As illustrated in FIG. 3, the second pipe 125 may be outwardly protruded from the housing 100, although the second pipe 125 may return to a gap 127 between the housing 100 and the incinerating furnace 101. The oxygen may descend to the lower portion of the housing 100 through the gap 127 between the surface of the inner wall and the incinerating furnace 101. Thus, the oxygen may be fed into the incinerating furnace 101 through the air pores 129 formed on the floor surface of the incinerating furnace 101. A virtue of the channel of the oxygen configured in this manner will be described hereinafter.

The oxygen may absorb the heat while remaining in the disc 123 and thus, enabling rapid combustion. The oxygen may descend downwards by surrounding the surface of the inner wall of the housing 100 and thus, adding a thermal barrier effect of the housing 100. The oxygen may allow a high temperature of the interior of the incinerating furnace 101 to be maintained and raise the temperature of the

225 oxygen to gain energy facilitating the combustion.

A detailed description of the channel through which the oxygen is fed is provided in conjunction with a configuration of the disc 123 with reference to FIG 4. A detailed planar view of the air pores 129 formed on the floor surface of the incinerating furnace 101 is provided with reference to FIG. 6.

230 FIG. 5 illustrates a detailed configuration of the heater 135.

The heater 135 may include heating wire 136 and an electrical contact unit 137. The electrical contact unit 137 may be disposed on a bottom end, and the heating coil 136 may be disposed upwards to be extended from the electrical contact unit 137. For example, when the electrical contact unit 137 is disposed on a top end, 235 high-temperature oxidation may be expedited in the electrical contact unit 137 because a high-temperature air current ascends upwards. Thus, a life of the heater 135 may be shortened or the heater 135 may operate erroneously. Hence, the electrical contact unit 137 may be provided to enable a cooling effect and the heating coil 136 may be designed to spread upwards to be exposed to a high temperature by 240 disposing the electrical contact unit 137 in a lower portion of the incinerating furnace 101 and feeding oxygen to the lower portion of the incinerating furnace 101. The heating coil 136 may be desirably provided with Kanthal, but not limited thereto. As illustrated in FIG. 5, the heating coil 136 may be designed to have a form of repeated paths to provide a sufficient amount of heat. The heater 135 may be heated up to 245 approximately 800°C through 1200°C and accordingly, high combustion efficiency may be achieved and Nox may rarely occur.

Due to characteristics of the foregoing configuration, the floor surface of the housing 100 may need to be opened and closed for disassembling and assembling of the components, for example, the heater 135, to replace the components. Thus, 250 the floor surface of the housing 100 may be designed to face an operator by rotating an entirety of the housing 100 around a fixed point. As illustrated in FIG. 7, a protruded fixing unit 160 may be provided at both ends of the housing 100. When

the housing 100 is allowed to rotate on the protruded fixing unit 160 as illustrated in FIG. 7, the floor surface of the housing 100 may be positioned opposite to the operator as illustrated in FIG. 8.

The housing 100 and the incinerating furnace 101 may be fabricated with stainless steel with oxidation resistance at an elevated temperature. Also, SUS 310, 304, 316, and the like may be used to fabricate the respective components based on their characteristics.

As described herein, a high-efficiency flame-free catalytic thermal oxidation incineration device may be provided and placed in an appropriate cabinet to be equipped with various automatic control devices.

Although a few embodiments of the present invention have been shown and described, the present invention is not limited to the described embodiments. Instead, it would be appreciated by those skilled in the art that changes may be made to these embodiments without departing from the principles and spirit of the invention, the scope of which is defined by the claims and their equivalents.

#### Industrial Availability

The present invention may be effectively used to treat various environmentally harmful substances generated from oil-refining facilities, processes of manufacturing semiconductors and light-emitting diode (LED) displays, and the like.

CLAIMS

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1. A flame-free catalytic thermal incineration device, comprising:  
an incinerating furnace to be disposed in a housing and including air pores;  
a reactant inlet to allow a reactant to be combusted to flow into the  
incinerating furnace;

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a reactant heating and feeding unit to be extended downwards from the  
reactant inlet, and including a heater and an opening in a lower portion of the  
reactant heating and feeding unit;

an oxygen feeding unit to feed oxygen through the air pores of the  
incinerating furnace; and

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a metallic oxide catalyst to fill in the incinerating furnace.

2. The device of claim 1, wherein the heater provided in the reactant  
heating and feeding unit includes heating wire and an electrical contact unit, and

wherein the electrical contact unit is disposed in a lower portion of the heater,

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and the heating coil is disposed to be extended upwards from the electrical contact  
unit.

3. The device of claim 1, wherein a plurality of the air pores of the  
incinerating furnace is formed on a floor surface of the incinerating furnace.

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4. The device of claim 3, wherein the oxygen feeding unit is provided to  
lead to a surface of an inner wall of the housing of the incinerating furnace to allow  
oxygen to descend along the surface of the inner wall of the housing of the  
incinerating furnace and to be fed through the air pores on the floor surface of the  
incinerating furnace.

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5. The device of claim 4, wherein the oxygen feeding unit comprises:

a hollow disc to be disposed surrounding the reactant inlet;

a first pipe to be in contact with an end of the disc to lead to the disc and

305 allowing oxygen to flow into the disc; and

a second pipe to be in contact with another end of the disc to lead to the disc  
and feeding oxygen escaping from the disc to the surface of the inner wall of the  
housing of the incinerating furnace.

310 6. The device of claim 1, wherein the opening to be formed in a lower  
portion of the reactant heating and feeding unit includes a plurality of air pores.

7. The device of claim 1, wherein the heater is heated up to  
approximately 800°C through 1200°C.

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8. The device of claim 1, wherein the metallic oxide catalyst includes  $\text{SiO}_2$ ,  
 $\text{Al}_2\text{O}_3$ ,  $\text{Fe}_2\text{O}_3$ , and  $\text{MnO}_x$ .

9. The device of claim 1, wherein the housing of the incinerating furnace  
320 includes a protruded fixing unit at both ends to allow an entirety of the housing to  
rotate on the protruded fixing unit.