

Title

ZERO-ENERGY CONSUMPTION PURIFYING APPARATUS FOR VOLATILE ORGANIC COMPOUNDS AND METHOD OF USING THE SAME

Background of the Invention

1. Field of the Invention

[0001] The present invention generally relates to a zero-energy consumption purifying apparatus and method for treating the volatile organic compounds (VOCs), and more particularly, to an apparatus utilizing absorption/ desorption concentrator and incineration equipment cooperating with a flow-mixing apparatus having auto air pressure balancing and temperature controlling functions to use waste heat exhausted by the flow-mixing apparatus as the desorption heat source for the absorption/desorption concentrator to achieve a nearly zero-energy consumption purifying process.

2. Description of the Prior Art

[0002] The specification of Taiwan Patent, Number I330105, discloses a zero-energy consumption purifying apparatus and method for volatile organic compounds (VOCs). The purifying apparatus generally includes: an incineration equipment with an exhaust gas pipe to inflow the gas containing the VOCs to be purified. The purified gas after incineration treatment is discharged from the purification gas pipe; and an absorption/desorption concentrator at least includes an absorption element and a desorption element. The intake pipe forkedly-connected with the purification gas pipe of the incineration equipment inflows the first purified gas treated by the incineration equipment but yet meets the effluent standard to be treated by the absorption element. The purified gas after absorption treatment is then fed back to the incineration equipment through the concentration gas pipe forkedly-connected with the exhaust gas pipe. Therefore, in the

above-mentioned conventional approach, the VOCs gas to be purified is first treated by the incineration equipment, and then may be optionally treated by the absorption/desorption concentrator depending on the requirement.

[0003] Due to the above-mentioned conventional skill still needing to be improved, the applicant of the present invention dedicates to develop an improved a zero-energy consumption purifying apparatus and method for treating the VOCs exhaust. The VOCs exhaust to be purified in the present invention would be first treated by the absorption/desorption concentrator and then be treated by the incineration equipment. In addition, by cooperation with a flow-mixing apparatus having auto air pressure balancing and temperature adjusting functions, the waste heat emitted by the incineration equipment may be utilized as a desorption heat source for the absorption/ desorption concentrator to perform the desorption cycle, thus a huge amount of fuel required by the incineration equipment may be saved and achieve a nearly zero-energy consumption purification treatment.

Summary of the Invention

[0004] The purpose of the present invention is to provide a zero-energy consumption purifying apparatus and method for processing the volatile organic compounds (VOCs) by respectively utilizing an absorption/desorption concentrator and an incineration equipment cooperative with a flow-mixing apparatus having auto air pressure balancing and temperature adjusting functions to achieve purifying treatment of nearly zero-energy consumption for the VOCs.

[0005] To achieve the above purpose, the present invention provides a zero-energy consumption purifying apparatus for treating volatile organic exhaust, including an absorption/desorption concentrator at least comprising an absorption element connected with an exhaust gas pipe and a purification

gas pipe, wherein the exhaust gas pipe is used to inflow a gas of volatile organic compound into the absorption element to form a purified gas after treatment, and the purified gas then inflows into the purification gas pipe and is discharged out from a stack; a desorption element is connected to a concentration gas pipe and communicated with a re-purification gas pipe, wherein the re-purification gas pipe is used to inflow a re-purified gas treated by an incineration equipment, and the re-purified gas is used as a desorption source for the desorption element, and the desorption source passing through the desorption element would inflow into an inlet of the incineration equipment via the concentration gas pipe; the incineration equipment has an inlet connected with the concentration gas pipe and an outlet connected with the re-purification gas pipe.

[0006] Moreover, the present invention provides a re-purification method for volatile organic compound, including the steps of: providing an absorption/desorption concentrator at least including: absorption elements connected with an exhaust gas pipe and a purification gas pipe, wherein the exhaust gas pipe is used to inflow a gas of volatile organic compound into the absorption element to form a purified gas after treatment, and the purified gas inflows into the purification gas pipe and then is discharged out from a stack; desorption elements connected to a concentration gas pipe and communicated with a re-purification gas pipe, wherein the re-purification gas pipe is used to inflow a re-purified gas treated by an incineration equipment, and the re-purified gas is used as a desorption source for the desorption element, and the desorption source passing through the desorption element inflows into an inlet of the incineration equipment via the concentration gas pipe; providing the incineration equipment having an inlet connected with the concentration gas pipe and an outlet connected with the re-purification gas pipe.

[0007] These and other objectives of the present invention

will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

Brief Description of the Drawings

[0008] FIG. 1 shows a block diagram of zero-energy consumption purifying apparatus for treating volatile organic exhaust according to one embodiment of the present invention.

[0009] FIG. 2 shows a block diagram of zero-energy consumption purifying apparatus for treating volatile organic exhaust according to another embodiment of the present invention.

[0010] FIG. 3 shows a flow chart of the purification method for treating the volatile organic exhaust according to the present invention.

It should be noted that all the figures are diagrammatic. Relative dimensions and proportions of parts of the drawings have been shown exaggerated or reduced in size, for the sake of clarity and convenience in the drawings. The same reference signs are generally used to refer to corresponding or similar features in modified and different embodiments.

Detailed Description

[0011] FIG. 1 shows a block diagram of zero-energy consumption purifying apparatus for treating volatile organic exhaust according to one embodiment of the present invention. FIG. 2 shows a block diagram of zero-energy consumption purifying apparatus for treating volatile organic exhaust according to another embodiment of the present invention. The purifying apparatus 10 for treating volatile organic exhaust in the present invention generally includes an absorption/desorption concentrator 11, an incineration equipment 13, and further includes a flow-mixing apparatus 12 with auto air

pressure balancing and temperature controlling function which will be explained hereinafter respectively. The absorption/desorption concentrator 11 at least includes an absorption element 111 and a desorption element 113, and the absorption/desorption concentrator 11 may further include a cooling element 115. The inlet of the absorption element 111 connects the exhaust gas pipe 21, and the outlet of the absorption element 111 connects the purification gas pipe 23. The exhaust gas pipe 21 is used to inflow the volatile organic compounds (VOCs) and deliver the VOCs into the absorption element 111 for absorption treatment. Purified gas will be formed after the absorption treatment and then vented to the purification pipe 23 to be discharged outside from stacks 40.

[0012] The desorption element 113 is serially connected between a concentration gas pipe 27 and a re-purification gas pipe 28b. The re-purified gas treated by the incineration equipment 13 inflows into the flow-mixing apparatus 12 through the re-purification gas pipe 28b for temperature control. The flow-mixing apparatus 12 is provided with auto air pressure balancing and temperature controlling functions. The re-purified gas passing through the flow-mixing apparatus 12 is used as a desorption source for the desorption element 113. The temperature of re-purified gas discharged from the re-purification gas pipe 28b is between 180°C to 220°C before being fed into the desorption element 113. The re-purified gas fed into and passing through the desorption unit 113 then forms the concentration gas. The concentration gas then flows into the concentration gas pipe 27 and further flows to the inlet of the incineration equipment 13. The concentrated gas flows again into the flow-mixing apparatus 12 for temperature adjustment after the treatment in the incineration equipment 13 to form the above-mentioned re-purified gas again.

[0013] The flow-mixing apparatus 12 is disposed between the re-purification branch pipe 28a and the re-purification gas pipe

28b, and the flow-mixing apparatus 12 is serially connected to the re-purification gas pipe 28b.

[0014] The re-purified gas treated by the incineration equipment 13 is in a high-temperature state. It would go to waste if the energy resulted from this temperature is not used. As shown in FIGs. 1 and 2, the re-purified gas in the high-temperature state in the present invention is recycled and reused on the desorption element 113 to provide the heat for the desorption treatment, thereby reducing the energy waste during the rotary desorption process.

[0015] Examples of the absorption/desorption concentrator 11 may be rotary concentrator, ring-type concentrator, fluidized bed concentrator or fixed bed concentrator. The absorption material may be, for example, zeolite, silicone, active carbon, carbon molecular sieves, foam rubber or active alumina.

[0016] The inlet of the incineration equipment 13 is connected to one end of the concentration gas pipe 27, and the outlet of the incineration equipment 13 is connected to one end of the flow-mixing apparatus 12. An example of the incineration equipment 13 may be regenerative thermal oxidizer, regenerative catalyst thermal oxidizer, recuperative thermal oxidizer, catalyst thermal oxidizer or other conventional thermal oxidizer. The catalyst may be, for example, Pt, Pd, V_2O_5 or the metal oxide combination thereof when conventional two-bed regenerative catalyst thermal oxidizer is utilized.

[0017] The inlet of the flow-mixing apparatus 12 is connected with the outlet of the incineration equipment 13. Examples of the flow-mixing apparatus 12 may be conventional gas-mixing tube, pressure control gas-mixing tube, cyclone hood apparatus, cylindrical gas-mixing tube or other conventional gas-mixing tube.

[0018] The gas containing VOCs may be, for example, engine exhaust, gas volatilized from organic solvents or air pollutants.

The VOCs in air may be alkanes, alkenes, aromatic compounds, ketones, ether, alcohols, organic acids, anime or the combination thereof, such as the isopropyl alcohol (IPA), acetone, propylene glycol monomethyl ether (PGME) or propylene glycol monomethyl ether acetate (PGMEA), etc, commonly used in the semiconductor industry.

[0019] As shown in FIGs. 1 and 2 in the present invention, additionally, at least one cooling element 115 may be disposed in the absorption/desorption concentrator 11 to connect the intake pipe 29a and exhaust gas pipe 29b. The intake pipe 29a is used to inflow a predetermined quantity of air, for example, to inflow a quantity of ambient air in the ratio of 5% to 60% of the total re-purified gas. In FIG. 1, one end of the exhaust gas pipe 29b is forkedly-connected with the concentration gas pipe 27. The exhaust pipe 29b is used to inflow the air passing through the cooling element 115. The air then flows through the exhaust gas pipe 29b and re-flows into the concentration gas pipe 27 to mix with the concentrated gas and finally flows into the incineration equipment for incineration treatment. In FIG. 2, one end of the exhaust gas pipe 29b is connected with the flow-mixing apparatus 12.

[0020] The cooling element 115 is disposed between the absorption elements 111 and the desorption elements 113. The cooling element 115 may be used to separate the absorption elements 111 and the desorption elements 113, thus the contamination issue between the absorption elements 111 and the desorption elements 113 may be properly solved.

[0021] As shown in FIGs. 1 and 2, the re-purification branch pipe 28a is connected between the flow-mixing apparatus 12 and the purification pipe 23. The re-purification gas branch pipe 28a is used to inflow a predetermined quantity of the re-purified gas, for example, in the ratio of 5% to 60% of the total re-purified gas. The re-purified gas in the ratio of 5% to 60% then flows through the re-purification gas branch pipe 25a and

purification pipe 23 and finally is discharged out from the stacks 40. The control valve 50a may be used to control the flux of re-purified gas flowing into the re-purification branch pipe 28a. For example, the flux controlled by the control valve 50a is in the ratio of 5% to 60% of the total volume of the re-purified gas.

[0022] As shown in FIGs. 1 and 2, the zero-energy consumption purifying apparatus 10 may further include fans 31, 32 and 33. Fan 31 is serially connected with the exhaust gas pipe 21, fan 32 is serially connected with the purification gas pipe 23, and fan 33 is serially connected with the concentration gas pipe 27.

[0023] It should be noted that the fan 33 is the fan with variable blowing rate serially connected with the concentration gas pipe 27. In the case that the utilized fan 33 in FIGs. 1 and 2 is a fan with variable blowing rate, if the predetermined furnace temperature can't be obtained through the heat provided by the desorbed VOCs when the concentration level of the absorption/desorption concentrator 11 is configured to be 15 times, the blowing rate of the variable fan 33 may be automatically decreased to increase the concentration level up to 15 times and obtain the desired furnace temperature. The purpose of zero-energy consumption may be achieved in the meanwhile by the heat provided by the VOCs which as a substitute for the fuel supply. When the concentration of the VOCs source (i.e. the non-concentrated exhaust) increases and the furnace temperature exceeds the protective value, the variable fan 33 may automatically increase the blowing rate to decrease the concentration level as a protection mechanism for the apparatus.

[0024] As shown in FIGs. 1 and 2, the zero-energy consumption purifying apparatus 10 of the present invention further includes a regulating valve 50b. The inlet of the regulating valve 50b may communicate with the concentration pipe 27 between variable fan 33 and desorption elements 113, and the outlet of the

regulating valve 50b may communicate with the exhaust gas pipe 21. When the concentration of the VOCs source (i.e. the non-concentrated exhaust) is low, and the concentration level achieves effective limitation or is configured to be fixed value, the opening of the regulating valve 50b would be enlarged to increase the absorption concentration at inlet as well as increase the desorption concentration at outlet, so that the heat provided by the VOCs may be increased to substitute the fuel supply and achieve the purpose of zero-energy consumption. When the concentration of the VOCs source (i.e. the non-concentrated exhaust) increases and the furnace temperature exceeds the protective value, the opening of the regulating valve 50b would be reduced to protect the apparatus.

[0025] FIG. 3 shows a flow chart of the purification method 60 for volatile organic exhaust according to the present invention. The purification method 60 for volatile organic exhaust includes providing an absorption/desorption concentrator 11 (step 601), providing an incineration equipment 13 (step 603), which will be explained hereinafter respectively. The functions of the absorption/desorption concentrator 11 in step 601 and the incineration equipment 13 in step 603 explained in detail in the above embodiment of zero-energy consumption purifying apparatus 10, thus redundant description is herein omitted. Furthermore, the preferred embodiment of the purification method 60 in the present invention may be supported by the zero-energy consumption purifying apparatus 10 explained with reference to the FIGs. 1 and 2.

[0026] In the present invention, the absorption/ desorption concentrator is first used to perform an absorption treatment for VOCs gas in the zero-energy consumption purifying apparatus 10, and the purified gas after absorption treatment is discharged from stacks. In the meantime, the concentrated gas desorbed from the absorption/desorption concentrator is incinerated by the incineration equipment to form a re-purified

gas. The re-purified gas may be used as a desorption source for the desorption concentrator. The zero-energy consumption purifying apparatus 10 and purification method 60 provided by the present invention may save the fuel required by the incineration equipment. This is the main contribution of the present invention.

Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

What is claimed is:

1. A zero-energy consumption purification apparatus, comprising:

an absorption/desorption concentrator, at least comprising:

absorption elements connected with an exhaust gas pipe and a purification gas pipe, wherein said exhaust gas pipe is used to inflow a gas of volatile organic compound into said absorption element to form a purified gas after treatment, and said purified gas inflows into said purification gas pipe and then is discharged out from a stack; and

desorption elements connected to a concentration gas pipe and communicated with a re-purification gas pipe, wherein said re-purification gas pipe is used to inflow a re-purified gas treated by an incineration equipment, and said re-purified gas is used as a desorption source for said desorption element, and said desorption source passing through said desorption element inflows into an inlet of said incineration equipment via said concentration gas pipe;

said incineration equipment, wherein said inlet of said incineration equipment is connected with said concentration gas pipe, and an outlet of said incineration equipment is connected with said re-purification gas pipe; and

a fan with a variable blowing rate serially connected with said concentration gas pipe to control said inflow of said desorption source into said inlet of said incineration equipment via said concentration gas pipe.

2. The zero-energy consumption purification apparatus according to claim 1, wherein said absorption/desorption

concentrator further comprises a cooling element between said absorption elements and said desorption elements and connected with an intake pipe and an exhaust gas pipe, and said intake pipe is used to inflow a predetermined quantity of air, and one end of said exhaust gas pipe is forkedly-connected with said concentration gas pipe, and said exhaust gas pipe is used to inflow said air passing through said cooling element into said concentration gas pipe.

3. The zero-energy consumption purification apparatus according to claim 2, further comprising a control valve and a re-purification branch pipe, wherein said re-purification branch pipe is connected between said purification gas pipe and said re-purification gas pipe and is used to discharge a predetermined quantity of said re-purified gas from said stack, and wherein said control valve is connected between said re-purification gas pipe and said re-purification branch pipe to control the quantity of said re-purified gas flowing into said re-purification branch pipe.
4. The zero-energy consumption purification apparatus according to claim 3, further comprising a flow mixing apparatus disposed between said re-purification branch pipe and said re-purification gas pipe, and said flow mixing apparatus serially connected with said re-purification gas pipe.
5. The zero-energy consumption purification apparatus according to claim 1, further comprising a regulating valve, wherein the inlet of said regulating valve communicates with said concentration gas pipe between said fan with variable blowing rate and said desorption element, and the

outlet of said regulating valve communicates with said exhaust gas pipe.

6. The zero-energy consumption purification apparatus according to claim 1, wherein said absorption/desorption concentrator is a rotary concentrator, ring-type concentrator, fluidized bed concentrator or fixed bed concentrator.
7. The zero-energy consumption purification apparatus according to claim 1, wherein said incineration equipment is a two-bed regenerative thermal oxidizer, two-bed regenerative catalyst thermal oxidizer, recuperative thermal oxidizer, recuperative catalyst thermal oxidizer, multi-bed regenerative thermal oxidizer, multi-bed regenerative catalyst thermal oxidizer, rotary regenerative thermal oxidizer or rotary regenerative catalyst thermal oxidizer.
8. A re-purification method for volatile organic compound, comprising:
 - providing a absorption/desorption concentrator, wherein said absorption/desorption concentrator at least comprises:
 - absorption elements connected with an exhaust gas pipe and a purification gas pipe, wherein said exhaust gas pipe is used to inflow a gas of volatile organic compound into said absorption element to form a purified gas after treatment, and said purified gas inflows into said purification gas pipe and then is discharged out from a stack; and
 - desorption elements connected to a concentration gas pipe and communicated with a re-purification gas pipe, wherein said re-purification gas pipe is used to inflow

a re-purified gas treated by an incineration equipment, and said re-purified gas is used as a desorption source for said desorption element, and said desorption source passing through said desorption element inflows into an inlet of said incineration equipment via said concentration gas pipe;

providing said incineration equipment, wherein said inlet of said incineration equipment is connected with said concentration gas pipe, and an outlet of said incineration equipment is connected with said re-purification gas pipe; and

controlling said inflow of said desorption source into said inlet of said incineration equipment via said concentration gas pipe using a fan with a variable blowing rate, wherein said fan is serially connected with said concentration gas pipe.

9. The re-purification method for volatile organic compound according to claim 8, further comprising a cooling element between said absorption elements and said desorption elements and connected with an intake pipe and an exhaust gas pipe, and said intake pipe is used to inflow a predetermined quantity of air, and one end of said exhaust gas pipe is forkedly-connected with said concentration gas pipe, and said exhaust gas pipe is used to inflow said air passing through said cooling element into said concentration gas pipe.

10. The re-purification method for volatile organic compound according to claim 9, further comprising a control valve and a re-purification branch pipe, wherein said re-purification branch pipe is connected between said purification gas pipe and said re-purification gas pipe and is used to discharge a predetermined quantity of said

re-purified gas from said stack, and wherein said control valve is connected between said re-purification gas pipe and said re-purification branch pipe to control the quantity of said re-purified gas flowing into said re-purification branch pipe.

11. The re-purification method for volatile organic compound according to claim 8, further comprising a flow mixing apparatus disposed between said re-purification branch pipe and said re-purification gas pipe, and said flow mixing apparatus serially connected with said re-purification gas pipe.
12. The re-purification method for volatile organic compound according to claim 8, further comprising a regulating valve, wherein the inlet of said regulating valve communicates with said concentration gas pipe between said fan with variable blowing rate and said desorption element, and the outlet of said regulating valve communicates with said exhaust gas pipe.
13. The re-purification method for volatile organic compound according to claim 8, wherein said absorption/desorption concentrator is a rotary concentrator, ring-type concentrator, fluidized bed concentrator or fixed bed concentrator.
14. The re-purification method for volatile organic compound according to claim 8, wherein said incineration equipment is a two-bed regenerative thermal oxidizer, two-bed regenerative catalyst thermal oxidizer, recuperative thermal oxidizer, recuperative catalyst thermal oxidizer, multi-bed regenerative thermal oxidizer, multi-bed regenerative catalyst thermal oxidizer, rotary

regenerative thermal oxidizer or rotary regenerative
catalyst thermal oxidizer.