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(54) **METHOD OF REDUCING AIR POLLUTANT
EMISSIONS FROM COMBUSTION
FACILITIES**

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(57) **ABSTRACT**

The present invention relates to a method of reducing air pollutant emissions such as dioxin or mercury from combustion facilities including furnaces and electricity generation equipment. More particularly, the invention relates to a method of reducing the amount of air pollutants such as dioxin or mercury from combustion facilities by inputting the precursor of nano-particles such as titanium dioxide photo-catalyst or reactive potassium iodide into the combustion facilities as a mixture with air or fuel supply of the combustion facilities, thereby allowing nano-particles to be synthesized during the combustion process and such synthesized nano-particles to absorb, decompose and adhere the air pollutants in the combustion facilities.

Fig. 1

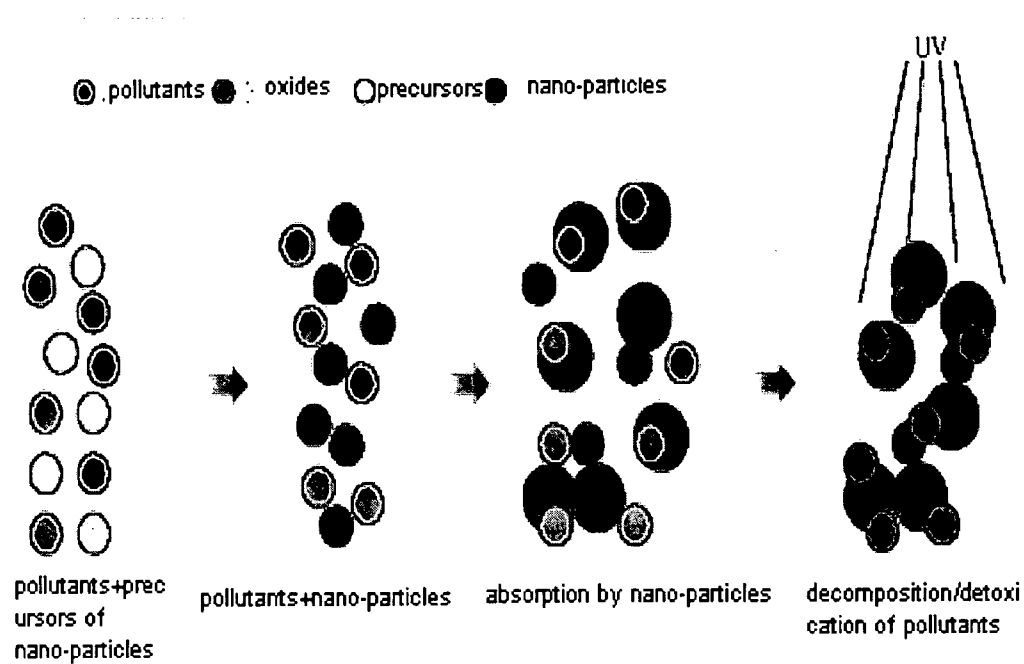
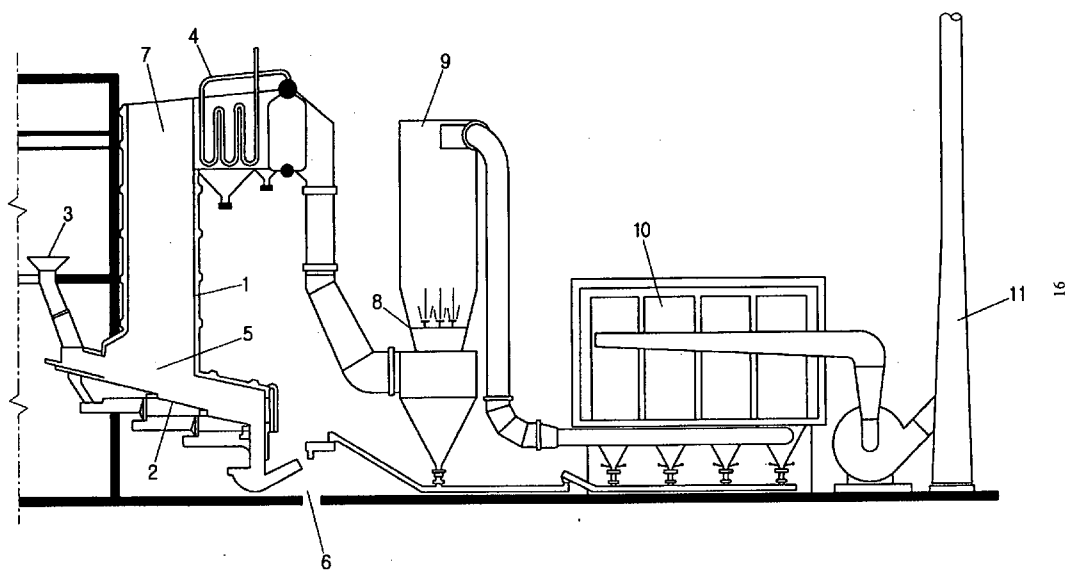
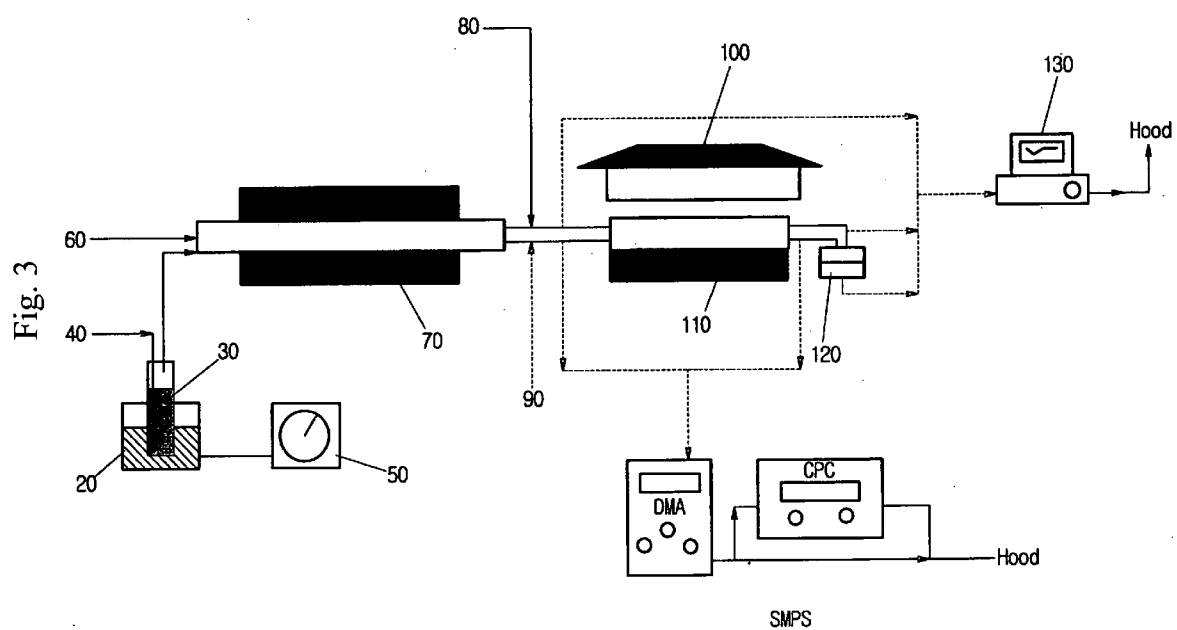


Fig. 2





METHOD OF REDUCING AIR POLLUTANT EMISSIONS FROM COMBUSTION FACILITIES

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a method of reducing air pollutant emissions such as dioxin or mercury from combustion facilities including furnaces and electricity generation equipment. More particularly, the invention relates to a method of reducing the amount of air pollutants such as dioxin or mercury from combustion facilities by inputting the precursors of nano-particles such as titanium dioxide photo-catalyst or reactive potassium iodide into the combustion facilities as a mixture with air or fuel supply of the combustion facilities, thereby allowing nano-particles to be synthesized during the combustion process and such synthesized nano-particles to decompose the air pollutants in the combustion facilities.

[0003] 2. Description of the Related Art

[0004] The waste treatment methods that involve the processes of crushing, burying and incinerating are generally well known in the art. Among these, the method of incinerating waste materials is most popularly utilized since it has the advantage of completely eradicating the waste materials. However, the incineration of the waste materials has a serious drawback of generating very toxic pollutants such as dioxin and mercury.

[0005] Dioxin is a chemical compound which is composed of two benzene rings which bind together with one or two oxygen atoms. Especially the hydrogen atoms which bind with the carbon atoms of the ring are replaced by chlorine atoms.

[0006] The creation mechanism of dioxin could be summarized in two types. The first type involves a reaction of organic materials such as chlorophenol or chlorobenzene which are known as precursors for the creation of dioxin. The second type involves de novo synthesis from inorganic carbon particles for the creation of dioxin.

[0007] U.S. Pat. No. 5,968,467 discloses a method of reducing total emissions of dioxin by repressing the generation of dioxin. More particularly, this patented invention discloses a method of reducing total amount of dioxin emissions by introducing an absorbent which is capable of repressing the generation of dioxin. The absorbents introduced in the patented invention include silicagel, activated carbon, chromosorb and zeolite. A maximum 51% of dioxin emissions could be reduced according to the disclosure of the patented invention. However, there is no disclosure in the patented invention related to the method of employing any form of nano-particles.

[0008] Korean patent publication No. 2003-0053233 also discloses a method of reducing total emissions of dioxin by repressing the generation of dioxin. More particularly, this patented invention discloses a method of reducing total amount of dioxin emissions by introducing a slag which is a by-product from steel manufacturing process. Again, there is no disclosure in the patented invention related to the method of employing any form of nano-particles.

SUMMARY OF THE INVENTION

[0009] The object of the present invention is to provide a method of effectively reducing pollutant emissions from combustion facilities.

[0010] In order to achieve the object of the present invention, the method of reducing pollutant emissions from combustion facilities according to the present invention comprises the step of removing the pollutants or their precursors from the combustion facilities by utilizing nano-particles or their precursors.

[0011] According to the present invention, the nano-particles or their precursors are inputted into the combustion facilities, particularly to the exact location where the pollutants or their precursors are generated.

[0012] According to the present invention, the precursors of the nano-particles are inputted into the combustion facilities and are converted into nano-particles through in situ formation during the combustion processes.

[0013] According to the present invention, the precursors of the nano-particles are inputted into the combustion facilities as a mixture with the air or fuel supply of the combustion facilities.

[0014] According to the present invention, the precursors of the nano-particles are inputted into the combustion facilities in the state of gas or liquid.

[0015] According to the present invention, the precursors of the nano-particles are sprayed into the combustion chamber of the combustion facilities.

[0016] According to the present invention, the precursors of the nano-particles are either nano-particles of titanium dioxide photo-catalyst or reactive potassium iodide.

[0017] According to the present invention, the pollutants are heavy metals which include mercury, cadmium, and arsenic.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. 1 is a schematic diagram showing the process of absorption and removal of pollutants by nano-particles.

[0019] FIG. 2 shows a set of apparatus for carrying out one preferred embodiment of the present invention for reducing air pollutant emissions from combustion facilities.

[0020] FIG. 3 shows a set of apparatus for mercury element removing experiment by in situ formation of the nano-particles.

DESCRIPTION OF THE NUMERIC ON THE MAIN PARTS OF THE DRAWING

[0021] 1: nano-particle precursors inlet

[0022] 2: furnace fire gate

[0023] 3: waste inlet

[0024] 4: waste heat boiler

[0025] 5: combustion chamber

[0026] 6: ground ash outlet

[0027] 7: secondary combustion chamber

[0028] 8: potassium hydroxide

[0029] 9: acid gas washing apparatus

[0030] 10: back filter

[0031] 11: chimney

- [0032] 20: oil bath
- [0033] 30: Ti precursor
- [0034] 40: pre-purified air
- [0035] 50: temperature controller
- [0036] 60: dry air
- [0037] 70: high temperature reactor
- [0038] 80: Hg
- [0039] 90: sheath air
- [0040] 100: UV lamp
- [0041] 110: mercury photo-reactor
- [0042] 120: filter
- [0043] 130: on-line mercury analyzer

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0044] Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings.

[0045] According to one preferred embodiment of the present invention for reducing air pollutant emissions such as dioxin or mercury from combustion facilities, the decomposition of the precursors of pollutants such as chlorophenol or chlorobenzene is promoted through an absorption by the nano-particles that are formed through in situ formation. Simultaneously, heavy metals such as mercury, cadmium, and arsenic are adhered to the above nano-particles.

[0046] According to the inventors of the present invention, it has been discovered that air pollutant emissions from combustion facilities could effectively be reduced by bring the precursor of pollutants such as chlorophenol in contact with the nano-particles and adhering chlorophenol to the nano-particles.

[0047] According to the present invention, the precursors of pollutants such as chlorophenol and mercury elements are absorbed or decomposed by the nano-particles, or adhered to the nano-particles.

[0048] Also, the adhesion, decomposition or absorption of the precursors such as chlorophenol is achieved by inputting the nano-particles into the exact location where air pollutants or their precursor are generated. The nano-particles are either manufactured prior to input or more preferably, the nano-particles manufactured through in situ formation. The precursors which form nano-particles are inputted to the combustion facilities in the state of gas or liquid and subsequently synthesized into nano-particles. The input location is either through the air supply section or the fuel supply section of the combustion facilities.

[0049] FIG. 1 is a schematic diagram showing the process of absorption and removal of pollutants by nano-particles. Initially, the pollutants exist in conjunction with the precursors of nano-particles. When the precursors are converted to nano-particles in the combustion chamber, the nano-particles absorb the pollutants. The absorbed pollutants are decomposed or detoxicated while the particles are growing.

[0050] The following is a detailed explanation through examples of the invention. It should be understood, however, that the detailed description and specific examples are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

EXAMPLE 1

[0051] FIG. 2 is a schematic diagram showing one preferred embodiment of the present invention for reducing air pollutant emissions from a combustion facility.

[0052] The combustion facility utilized in the preferred embodiment of the present invention comprises a furnace fire gate (2), waste inlet (3), waste heat boiler (4), furnace combustion chamber (5), acid gas washing apparatus (9), back filter (10), and chimney (11).

[0053] The method of reducing air pollutants such as dioxin or mercury from a combustion facility comprises the steps of forming nano-particles in a secondary combustion chamber (7) at high temperature by spraying the liquid phase or vapor phase precursors of nano-particles into the secondary combustion chamber (7) via an inlet (1); repressing the creation of pollutants such as dioxin or mercury as such formed nano-particles are passing through the emission gas processing equipment such as a waste heat boiler (4), and acid gas washing apparatus (9); removing the pollutants through promoting the oxidation decomposition reaction of the pollutants or repressing the emission of pollutants such as dioxin or mercury from a chimney (11) by absorbing and adhering the pollutants to the nano-particles and separating the nano-particles using a back filter after initially allowing them to grow. At the same time, the present invention could suppress the dissolution of toxic materials due to the scattered ashes discharged from a ground ash outlet (6) under the legally permitted value by preventing the pollution by secondary residues from incinerating equipments.

EXAMPLE 2

[0054] According to the present invention, the following experiment was carried out in order to prove the effectiveness of In situ formation of the nano-particles for removing pollutants.

[0055] FIG. 3 shows a set of apparatus for mercury element removing experiment by in situ formation of the nano-particles. In the experiment, a high temperature reactor (70) which consists of a tube furnace and quartz reactor is utilized for removing mercury through directly manufacturing the nano-particles from a titanium precursor (30) (titanium isopropoxide). As for the titanium precursor, 97% titanium (IV) isopropoxide (TTIP), $(\text{Ti}[\text{OCH}(\text{CH}_3)_2]_4)$ is used.

[0056] A vaporized titanium precursor is transported to the high temperature reactor (70) by passing Ar gases (pre-purified 99.99%) (40) with a pre-controlled fixed flow rate through the container for the precursors (30). The vaporized titanium precursor is instantly oxidized to TiO_2 in the high temperature reactor (70) and as the temperature of the gas state TiO_2 is lowered, it starts to condense and becomes a solid state TiO_2 nano-particles. More than 90% of the TiO_2 nano-particles created in this instant are anatase which

possesses the property of photo-catalyst due to the high temperature environment. Mercury photo-reactor (110) is manufactured by quartz or boro silica which is permeable to ultraviolet ray. An UV lamp (100) which is utilized as an ultraviolet source is installed on the upper section of the mercury photo-reactor (110). The liquid state mercury elements (80) are vaporized to particle-less purified carrier gas (90) and is transported to the mercury photo-reactor (110). The concentration of the gas state mercury (80) is controlled by the variation in the flow rate of the carrier gas. The variation of mercury concentration at the inlet and outlet of the mercury photo-reactor (110) is analyzed by an on-line mercury analyzer (130). Table 1 below shows the detailed results. As shown in Table 1, some of the results show that the effectiveness of nano-particles by in situ formation reaches to a 100% level. This shows the superior effectiveness of the present invention.

TABLE 1

	Oil bath (° C.)	Air flow rate (sL/min)	N ₂ flow rate (TTIP) sCC/min	Ar flow rate (Hg) sCC/min	Total flow rate sL/min	UV on conc. (μg/m ³)	UV off conc. (μg/m ³)	Removal efficiency (%)	Retention Time(s) Furnace2
1	60	1.5	200	15	1.715	69	40	46	47
2	80	1.5	200	10	1.71	35	14	67	47
3	80	1.5	200	15	1.715	71	40	43	47
4	80	1.5	300	15	1.815	64	25	61	45
5	80	1.1	400	15	1.515	77	34	57	58
6	90	1.5	500	30	2.03	82	3	97	39
7	110	1.5	200	50	2.05	60	0	100	47
8	90	2	200	45	2.545	64	1	98.4	33

[0057] As explained in the detailed disclosure of the present invention for reducing air pollutant from combustion facilities, the method of utilizing nano-particles for removing pollutants such as dioxin or mercury has a superior effectiveness which could replace the present use of a large amount of charcoal or other costly absorbents.

What is claimed is:

1. A method of reducing air pollutant emissions from combustion facilities, wherein the air pollutant emissions from combustion facilities or their precursors are removed by utilizing nano-particles or their precursors.

2. The method according to claim 1, wherein the nano-particles or their precursors are inputted into a specific location of the combustion facilities, wherein the specific location is the location where said air pollutant emissions or their precursors are generated.

3. The method according to claim 2, wherein the precursors of the nano-particles are inputted into the combustion facilities and then converted into nano-particles through in situ formation in the combustion facilities during the combustion process.

4. The method according to claim 3, wherein the precursors of the nano-particles are inputted into the combustion facilities in conjunction with air or fuel supply for the combustion facilities.

5. The method according to claim 3, wherein the precursors of the nano-particles are inputted into the combustion facilities in the state of gas or liquid.

6. The method according to claim 5, wherein the precursors of the nano-particles are sprayed into a combustion chamber of said combustion facilities.

7. The method according to claim 1, wherein the nano-particles are titanium dioxide photo-catalyst nano-particles or reactive potassium iodide nano-particles.

8. The method according to claim 1, wherein the air pollutant emissions are heavy metals which include mercury, cadmium, and arsenic.

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