Title: PLASMA AND BIO FILTER HYBRID GAS CLEANING SYSTEM

Abstract: There is provided a plasma and bio filter hybrid gas cleaning system in a contaminated noxious gas processing system, comprising: a pneumatic nozzle for supplying a contaminated noxious gas exhausted from a contaminated gas exhausting source, together with water; a plasma reaction unit positioned under the pneumatic nozzle and connected to a high voltage application unit; a bio filter unit positioned under the plasma reaction unit; a water tank positioned under the bio filter unit, for storing the water flowing down from the bio filtering unit part; a water pump for circulating the water stored in the water tank to the pneumatic nozzle; and a blower for supplying the contaminated noxious gas to the pneumatic nozzle. In accordance with the plasma and bio filter hybrid gas cleaning system, the water and the noxious gas are simultaneously supplied to the plasma reaction unit, so that the performance of decomposing the noxious gas is increased; water particles and oxygen are uniformly supplied to the bio filter unit through the pneumatic nozzles and the plasma discharge, so that the noxious gas cleaning function of microorganisms is improved; and the processing capacity increases while reducing pressure loss, compared to a conventional bio filter.

Fig. 2
Description
PLASMA AND BIO FILTER HYBRID GAS CLEANING SYSTEM

Technical Field
[1] The present invention relates to a plasma and bio filter hybrid gas cleaning system, and more particularly, to a plasma and bio filter hybrid gas cleaning system which simultaneously supplies water and a noxious gas to a plasma reaction unit so as to accelerate plasma discharge and to improve the performance of decomposing the noxious gas, which uniformly supplies fine water particles and oxygen to a bio filter unit through pneumatic spray nozzles and plasma discharge so as to improve the microbial function for purifying the noxious gas, and which increases the processing capacity while reducing the pressure loss, compared to a conventional bio filter.

Background Art
[2] A conventional bio filter system removes a noxious gas by the decomposition of microorganisms and uses microorganisms which are present in city garbage, hay, farmyard manure, porous clay and the like as the filler. In the conventional bio filter system, since it is very important to control water, temperature and dust to maintain continuous performance, a water control system is additionally needed. Further, since it is necessary to clean a bio mass for periodical maintenance and management, frequent cleaning results in a great amount of waste water and increases processing costs. A bio trickling filter has been widely used. The bio trickling filter sprays the water with nutritive elements and neutralizing agents from the top of a filling layer of an inorganic carrier of a single or more layer structure as illustrated FIG. 1 to the carrier, through a pump and a spray nozzle, to supply the water and nutritive elements required for microorganisms in the filling layer of the carrier.

Disclosure of Invention

Technical Problem
[3] However, when a cleaning time becomes longer in the bio trickling filter, a contaminated gas increasingly dissolves and an amount of the dissolved contaminate gas also increases in the water stored in a water tank. As a result, decay is likely to occur, to cause water pollution. Moreover, since the cleaning capacity is limited per unit volume, the system of the bio trickling filter is to be configured in a multi level structure as the cleaning capacity increases. Consequently, the volume of the system and the manufacturing costs thereof sharply increase. Moreover, when the noxious gas of the high concentration of 200 ppm or above is supplied, the viability of microorganisms decreases so that the performance of removing the noxious gas suddenly drops.
Technical Solution

The present invention provides a plasma and bio filter hybrid gas cleaning system which increases the cleaning capacity of the system at less pressure loss, without incurring tremendous costs, by applying a combination of a plasma type filtration system and a bio filtering system while keeping the advantages of the plasma and the bio filter, and which processes a noxious gas of high concentration which can be not processed by the bio filter system only.

FIG. 2 is a schematic view of a plasma and bio filter hybrid gas cleaning system according to an exemplary embodiment of the present invention, and FIG. 3 is a schematic view of gliding discharge plasma used for the plasma and bio filter hybrid gas cleaning system according to the present embodiment.

According to an exemplary embodiment of the present invention, there is provided a plasma and bio filter hybrid gas cleaning system in a contaminated noxious gas processing system, comprising: a pneumatic nozzle 3 for supplying a contaminated noxious gas exhausted from a contaminated gas exhausting source and water; a plasma reaction unit 2 positioned under the pneumatic nozzle 3 and connected to a high voltage application unit; a bio filter unit 9 positioned under the plasma reaction unit 2; a water tank 7 positioned under the bio filter unit 9 and storing the water which flows down from the bio filter unit 9; a water pump 8 for circulating the water stored in the water tank 7 to the pneumatic nozzle 3; and a blower 10 for supplying the contaminated noxious gas to the pneumatic nozzle 3.

The plasma reaction unit 2 is positioned at the end of the pneumatic nozzle 3 and under the center of the pneumatic nozzle 3.

The bio filter unit 9 is formed by stacking a porous inorganic carrier including microorganisms in a multi-layer manner. The plasma and bio filter hybrid gas cleaning system may further comprise a neutralizing agent supply unit 4 and a nutrient supply unit 5 for respectively and quantitatively supplying a neutralizing agent and a nutrient to the water tank 8, and an air bubble supply unit 6 for continuously supplying oxygen to the microorganisms present in the water tank 8.

The pneumatic nozzle 3 is an inside mixing type to generate fine water drops by spraying gas and liquid being mixed inside the pneumatic nozzle 3, and it has a spray angle within the range of 10° to 120°. One or more pneumatic nozzles 3 may be positioned.

The pneumatic nozzle 3 supplies the fine water drops and the noxious gas to the plasma reaction unit 2 so as to activate plasma reaction. Simultaneously, the pneumatic nozzle 3 uniformly and widely supplies the water, nutritive element and oxygen to the bio filter unit 9 so as to improve the function of the microorganisms to purify the
noxious gas.

The plasma reaction unit 2 may be a reactor for a low temperature plasma which is selected from typical RF plasma, pulse corona, dielectric barrier discharge (DBD) plasma and gliding discharge plasma. Like a picture of plasma generation of the gliding discharge plasma reactor as shown in FIG. 4, preferably, the plasma reaction unit 2 may use the gliding discharge plasma which generates an arc when an alternating current or a pulse high voltage is applied to both ends of a metal plate with a section shape similar to two semicircles by a high voltage generation unit 1, and which disappears by moving the arc, along the metal plate side when the gas is supplied to the center thereof.

The plasma reaction unit 2 is positioned under the center of the pneumatic nozzle 3 so as to supply the water and gas simultaneously to the plasma reaction unit 2 an arc generation part, and a number of the plasma reaction units 2 may be used to be positioned at the same intervals, depending on the number of the pneumatic nozzles 3. The plasma reaction unit 2 reacts (discharges) at the place where the fine water drops and the noxious gas are supplied, to generate a great number of OH radicals. The generated OH radicals activate the chemical reaction of the noxious gas, to decompose the noxious gas. Specifically, since the fine water drops and the noxious gas are simultaneously supplied to accelerate the generation of the OH radicals, the decomposition performance of plasma is improved.

The bio filter unit 9 may be formed by stacking the porous inorganic carrier, such as polyurethane foam in a rectangular block shape, in the multi-layer structure.

The nutrient supplied through the nutrient supply unit contains a great quantity of inorganic nutritive elements required for metabolism of the microorganisms as well as nitrogen (N), phosphorus (P), potassium (K) assisting the microorganisms in inhabiting, and it is periodically supplied to the water tank through an automatic control supply unit.

The neutralizing agent supplied through the neutralizing agent supply unit 4 is useds sodium hydroxide (NaOH) and is intermittently but continuously supplied to the water tank 7 through the automatic control supply unit, to prevent the microorganisms from being oxidized and to maintain the neutrality of appropriate pH.

Advantageous Effects

As described above, in the plasma and bio filter hybrid gas cleaning system according to the exemplary embodiments of the present invention, since water and a noxious gas are simultaneous supplied to the plasma reaction unit, the plasma discharge is accelerated to improve the performance of decomposing the noxious gas. Furthermore, since water ions and oxygen are uniformly supplied to the bio filter unit
through the pneumatic nozzles and the plasma discharge, the noxious gas cleaning
function of microorganisms is improved. Furthermore, the processing capacity
increases while reducing pressure loss, compared to a conventional bio filter.

Brief Description of the Drawings

[17] The above and other features and advantages of the present invention will become
more apparent by describing in detail exemplary embodiments thereof with reference
to the attached drawings in which:

[18] FIG. 1 is a schematic view of a conventional bio filter system;

[19] FIG. 2 is a schematic view of a plasma and bio filter hybrid gas cleaning system
according to an exemplary embodiment of the present invention;

[20] FIG. 3 is a schematic view of gliding discharge plasma reactor used for the plasma
and bio filter hybrid gas cleaning system of FIG. 2; and

[21] FIG. 4 is a picture of plasma generation of gliding discharge plasma reactor.

[22] Explanation on essential elements of drawings>

[23] 1: high voltage generation unit 2: plasma reaction unit

[24] 3: pneumatic nozzle 4: neutralizing agent supply unit

[25] 5: nutrient supply unit 6: air bubble supply unit

[26] 7: water tank 8: water pump

[27] 9: bio filter unit 10: blower

Mode for the Invention

[29] The present invention will now be described more fully hereinafter with reference
to the accompanying drawings, in which preferred embodiments of the invention are
shown. Like numbers refer to like elements throughout the specification and drawings.
Where the function and constitution are well-known in the relevant arts, no further
discussion thereof will be presented in the detailed description of the present invention
in order not to unnecessarily make the gist of the present invention unclear.

[30] FIG. 2 illustrates a plasma and bio filter hybrid gas cleaning system according to an
exemplary embodiment of the present invention.

[31] In the plasma and bio filter hybrid gas cleaning system of FIG. 2, a contaminant,
such as a noxious gas or a bad smell, is mixed with water, which is absorbed from a
contaminated gas exhausting source by the filtration system through a blower 10, is
mixed with water conveyed from a water tank 7 by a water pump 8, and is sprayed
from a pneumatic nozzle 3 positioned above the filtration system. A plasma reaction
unit 2 is positioned just under the pneumatic nozzle 3 so that the noxious gas and water
particles sprayed through the pneumatic nozzle 3 can pass through two discharge poles
of the plasma reaction unit 2.
The noxious gas passing through the plasma reaction unit 2 is decomposed by a great number of OH radicals generated in a plasma reaction unit 2. Specifically, since fine water drops and the noxious gas are simultaneously supplied to the plasma reaction unit 2 so as to activate the generation of the OH radicals, the plasma dissolution performance is improved.

The residual noxious gas passing through the plasma reaction unit 2 is again removed while passing through a bio filter unit 9 formed of a porous inorganic carrier, such as polyurethane foam in a rectangular block shape, stacked in a multi layer structure. The fine water drops simultaneously supplied together with the noxious gas are uniformly sprayed to the inorganic carrier so as to sufficiently supply nutritive elements, water and oxygen to microorganisms.

The water drops passing through the bio filter unit 9 are collected in the water tank 7 positioned under the bio filter unit 9 and is moved to the pneumatic nozzle 3 through the water pump 8 so as to be continuously circulated.

The water tank 7 is connected to a nutrient supply unit 5 and a neutralizing agent supply unit 4 which respectively periodically supply a nutrient and a neutralizing agent to the water tank 7 through an automatic control supply unit. The nutrient contains a large quantity of inorganic nutritive elements required for metabolism of the microorganisms as well as N, P and K assisting the microorganisms in inhabiting, and the neutralizing agent uses NaOH so as to prevent the microorganisms from being oxidized and to maintain the neutrality of appropriate pH.

Further, the water tank 7 is connected to an air bubble supply unit 6 to continuously supply oxygen to the microorganisms present in the water tank 7.

The invention has been described using preferred exemplary embodiments. However, it is to be understood that the scope of the invention is not limited to the disclosed embodiments. On the contrary, the scope of the invention is intended to include various modifications and alternative arrangements within the capabilities of persons skilled in the art using presently known or future technologies and equivalents. The scope of the claims, therefore, should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.
Claims

[1] A plasma and bio filter hybrid gas cleaning system in a contaminated noxious gas processing system, comprising:
a pneumatic nozzle 3 for supplying a contaminated noxious gas exhausted from a contaminated gas exhausting source, together with water;
a plasma reaction unit 2 positioned under the pneumatic nozzle 3 and connected to a high voltage application unit;
a bio filter unit 9 positioned under the plasma reaction unit 2;
a water tank 7 positioned under the bio filter unit 9, for storing the water flowing down from the bio filtering unit part 9;
a water pump 8 for circulating the water stored in the water tank 7 to the pneumatic nozzle 3; and
a blower 10 for supplying the contaminated noxious gas to the pneumatic nozzle 3.

[2] The plasma and bio filter hybrid gas cleaning system of claim 1, wherein the plasma reaction unit 2 is positioned at the end of the pneumatic nozzle 3.

[3] The plasma and bio filter hybrid gas cleaning system of claim 1, wherein the plasma reaction unit 2 is positioned under the center of the pneumatic nozzle 3.

[4] The plasma and bio filter hybrid gas cleaning system of claim 1, wherein the bio filter unit 9 is formed by stacking a porous inorganic carrier containing microorganisms in a multi-layer structure, and the porous inorganic carrier is formed of polyurethane foam having a rectangular block shape.

[5] The plasma and bio filter hybrid gas cleaning system of claim 1, further comprises:
a neutralizing agent supply unit 4 and a nutrient supply unit 5 for quantitatively supplying a neutralizing agent and a nutrient to the water tank 7, and wherein the neutralizing agent supplied by the neutralizing agent supply unit 4 is useds sodium hydroxide (NaOH) and is intermittently but continuously supplied to the water tank 7 through an automatic control supply unit so as to prevent the microorganisms from being oxidized and to maintain the neutrality of appropriate pH, and
the nutrient supplied through the nutrient supply unit 5 contains a great quantity of inorganic nutritive elements required for metabolism of the microorganisms as well as nitrogen (N), phosphorus (P), potassium (K) assisting the microorganisms in inhabiting and it is periodically supplied to the water tank 7 through the automatic control supply unit.

[6] The plasma and bio filter hybrid gas cleaning system of claim 1, further
comprising:
an air bubble supply unit 6 for continuously supplying oxygen to the microorganisms present in the water tank 78.

[7] The plasma and bio filter hybrid gas cleaning system of claim 1, wherein the pneumatic nozzle 3 is an inside mixing type to produce fine water drops by spraying gas and liquid being mixed inside the pneumatic nozzle 3, it have a spray angle within the range of 10° to 120°, and one or more pneumatic nozzles 3 are positioned.

[8] The plasma and bio filter hybrid gas cleaning system of claim 1, wherein the plasma reaction unit 2 is a reactor for a low temperature plasma selected from typical RF plasma, pulse corona, dielectric barrier discharge (DBD) plasma and gliding discharge plasma.

[9] The plasma and bio filter hybrid gas cleaning system of claim 1, wherein the plasma reaction unit 2 is the gliding discharge plasma reactor which generates an arc by applying an alternating current or a pulse high voltage to both ends of a metal plate with a sectional shape similar to two semicircles, and the arc disappears while the arc is moved along the surface of the metal plate by supplying a gas to the center.
INTERNATIONAL SEARCH REPORT

PCT/ISA/210 (second sheet) (April 2007)

A. CLASSIFICATION OF SUBJECT MATTER

**BOID 53/32(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8 BOID

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility models and applications for Utility Models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS(KIPO internal) "plasma", "bio", "filter", "gas" and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☐ Further documents are listed in the continuation of Box C

☒ See patent family annex

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Date of the actual completion of the international search

23 OCTOBER 2007 (23 10 2007)

Date of mailing of the international search report

24 OCTOBER 2007 (24.10.2007)

Name and mailing address of the ISA/KR

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