DESCRIPTION

TITLE OF THE INVENTION: CHLORINE DIOXIDE GENERATOR

TECHNICAL FIELD

[0001] The present invention relates to a chlorine dioxide generator (hereinafter, referred to simply as "generator") configured to generate chlorine dioxide gas through a reaction between a chlorite and an acidic substance.

BACKGROUND ART

[0002] Conventionally, there are known instruments or devices for generating chlorine dioxide gas through reaction between a solution of chlorite and an acidic substance (see Patent Document 1).

PRIOR ART DOCUMENT

PATENT DOCUMENT

[0003] Patent Document 1: Japanese Unexamined Patent Application Publication No. 2007-145654

SUMMARY ~~OF THE INVENTION~~

OBJECT TO BE ACHIEVED ~~BY INVENTION~~

[0004] However, the conventional chlorine dioxide generators were not designed for portability. Many of these are designed to be placed on a desk or a floor surface or they are large and complicated devices. Further, even when the device is formed compact for providing portability (mobility), the device would suffer such problem as possibility of liquid dripping or spill from inside the device. Although liquid dripping or spill can be prevented by ensuring sealing of the container, ensuring of sealing causes a new problem of increased resistance in discharging of chlorine dioxide gas.

[0005] Further, in case fumigation of a room, indoor space or other space with chlorine dioxide gas is desired, it is necessary to generate chlorine dioxide gas at a certain high concentration. Increase of the concentration of chlorine dioxide gas to be generated can be easily achieved via increase of the concentration of the acidic substance. However, such high concentration of acidic substance, e.g. high concentration of sulfuric acid, which is an extremely hazardous substance, requires caution in its handing. On the other hand, if

the concentration of the acidic substance is lowered in order to avoid danger, this results in reduction in the generation efficiency of chlorine dioxide gas, thus causing a problem of making satisfactory fumigation treatment impossible.

[0006] The present disclosure~~invention~~ has been made in view of the above-described state of the art. The object of the present disclosure~~invention~~ is to provide a chlorine dioxide generator that can be formed compact and allows safe carrying (transport) of a source of chlorine dioxide gas generation through effective prevention of liquid dripping or spill and that also allows one-setting transitory generation of a large amount of chlorine dioxide gas even with a low concentration of acidic substance and achieves reduction in the fumigation treatment period (waiting period for a human), thus allowing access by the human to the inside of the fumigated room immediately after air ventilation thereof.

MEANS FOR ACHIEVING THE OBJECT

[0007] For achieving the above-noted object, in an aspect according to the present disclosure~~invention~~, there is provided chlorine dioxide generator configured to generate chlorine dioxide gas through a reaction between a chlorite and an acidic substance, the generator comprising: a container body which is deformable in response to application of a force thereto from the outside; wherein the container body includes a gas discharge port formed of a gas-permeable, water-impermeable or gas-permeable, water-permeation retardant member, the container body except for the gas discharge port being sealed, thus having a water-impermeable construction; the container body contains therein a solid acidic composition and an aqueous chlorite solution under a non-contact condition from each other; the solid acidic composition comprises a porous material containing an acidic substance that exhibits acidity when dissolved in water; the aqueous chlorite solution is sealed within an easily breakable enclosure; the porous material is disposed closer to the gas discharge port than to the enclosure; the generator further comprises an insulating member for insulating the porous material and the enclosure from each other, the insulating member having at least one hole portion and being disposed in such a manner as to be capable of preventing displacement of the porous material toward the enclosure; and when the container body is deformed, the enclosure contained therein is broken to bring the aqueous

chlorite solution into contact with the solid acidic composition, whereby chlorine dioxide gas is generated and this chlorine dioxide gas is discharged via the gas discharge port to the outside of the container body. In another aspect, there is provided a chlorine dioxide generator configured to generate chlorine dioxide gas through a reaction between a chlorite and an acidic substance, the generator comprising: a container body which is deformable in response to application of a force thereto from the outside; wherein the container body includes a gas discharge port formed of a gas-permeable, water-impermeable or gas-permeable, water-permeation retardant member, the container body except for the gas discharge port being sealed, thus having a water-impermeable construction; the container body contains therein a solid chlorite composition and an aqueous solution of an acidic substance under a non-contact condition from each other; the solid chlorite composition comprises a porous material impregnated with an aqueous solution of chlorite; the aqueous solution of acidic substance is sealed within an easily breakable enclosure; the porous material is disposed closer to the gas discharge port than to the enclosure; the generator further comprises an insulating member for insulating the porous material and the enclosure from each other, the insulating member having at least one hole portion and being disposed in such a manner as to be capable of preventing displacement of the porous material toward the enclosure; and when the container body is deformed, the enclosure contained therein is broken to bring the aqueous acidic substance solution into contact with the solid chlorite composition, whereby chlorine dioxide gas is generated and this chlorine dioxide gas is discharged via the gas discharge port to the outside of the container body. T~~t~~here is provided a chlorine dioxide generator configured to generate chlorine dioxide gas through a reaction between a chlorite and an acidic substance, the generator comprising:

a container body which is deformable in response to application of a force thereto from the outside;

wherein the container body includes a gas discharge port formed of a gas-permeable, water-impermeable or gas-permeable, water-permeation retardant member, the container body except for the gas discharge port being sealed, thus having a water-impermeable construction;

the container body contains therein a solid acidic composition and an aqueous chlorite solution under a non-contact condition from each other;

the solid acidic composition comprises a porous material containing an

acidic substance that exhibits acidity when dissolved in water;

the aqueous chlorite solution is sealed within an easily breakable enclosure; and

when the container body is deformed, the enclosure contained therein is broken to bring the aqueous chlorite solution into contact with the solid acidic composition, whereby chlorine dioxide gas is generated and this chlorine dioxide gas is discharged via the gas discharge port to the outside of the

porous material, it is possible to reduce the amount of free water in the reaction system. Namely, it is possible to cause the acid substance to react at a higher concentration than the apparent concentration of this acidic substance in the solid acidic composition. Therefore, the contact area (reaction opportunity) between the chlorite and the acidic substance is increased so that the reaction rate becomes higher, whereby the reaction occurs at one short time altogether, whereby the chlorine dioxide gas is generated drastically in a short period of time altogether (at one setting and in a transitory manner).

[0012] According to a second characterizing feature of the chlorine dioxide generator of the present disclosure~~invention~~, there is provided a chlorine dioxide generator configured to generate chlorine dioxide gas through a reaction between a chlorite and an acidic substance, the generator comprising:

a container body which is deformable in response to application of a force thereto from the outside;

wherein the container body includes a gas discharge port formed of a gas-permeable, water-impermeable or gas-permeable, water-permeation retardant member, the container body except for the gas discharge port being sealed, thus having a water-impermeable construction;

the container body contains therein a solid chlorite composition and an aqueous solution of an acidic substance under a non-contact condition from each other;

the solid chlorite composition comprises a porous material impregnated with an aqueous solution of chlorite;

the aqueous solution of acidic substance is sealed within an easily breakable enclosure; and

when the container body is deformed, the enclosure contained therein is broken to bring the aqueous acidic substance solution into contact with the solid chlorite composition, whereby chlorine dioxide gas is generated and this chlorine dioxide gas is discharged via the gas discharge port to the outside of the container body.

[0013] With the above-described arrangement, in the container body, its gas discharge port is formed of a gas-permeable, water-impermeable or gas-permeable, water-permeation retardant member, the container body except for the gas discharge port being sealed, thus having a water-impermeable construction. Therefore, this is hardly any concern about

in a transitory manner).

[0017] According to a third characterizing feature of the inventive chlorine dioxide generator, the container body is provided in the form of a flexible tube that can be flexed into an arcuate shape in response to application of the external force.

[0018] With the above-described arrangement, the container body can be configured as a container body which is in the form of a tube (stick) having a bottomed (i.e. having a bottom) cylindrical shape having an open top. Hence, the chlorine dioxide generator can be formed compact, so that it becomes possible to carry (transport) a chlorine dioxide generation source.

Further, if the tubular container body storing therein e.g. a solid acidic composition and an aqueous chlorite solution under a non-contact condition from each other is broken with using a crimping tool or one applies an external force to this container body to bend it into an arcuate shape, with holding its right end with the right hand and the left end with the left hand, the easily breakable enclosure stored therein can be broken very easily.

[0019] According to a fourth characterizing feature of the chlorine dioxide generator of the present disclosure~~invention~~, said acidic substance comprises sulfuric acid and said chlorite comprises sodium chlorite or potassium chlorite.

[0020] With the above-described arrangement, sulfuric acid as an example of the acidic substance has good storage stability and will not generate corrosive gas and show no change in its concentration even after it is caused to be carried by the porous material. Hence, it had good handling readiness. Further, sodium chlorite or potassium chlorite as an example of the chlorite is easily available, so the present disclosure~~invention~~ can be embodied easily.

[0021] According to a fifth characterizing feature of the chlorine dioxide generator of the present disclosure~~invention~~, said acidic substance has a concentration of 30 wt.% or less and said chlorite has a concentration from 0.1 to 30 wt.%.

[0022] With the above-described arrangement, if the concentration of the acidic substance exceeds 30 wt.%, this will result in increase in the viscosity of the solution, which results, in turn, in greater difficulty of dispersion. As a result, there will occur significant irregularity in the acidic substance prepared, disadvantageously. Further, if the concentration of chlorite falls below 0.1 wt.%, this may cause a problem that shortage of chlorite occurs in the generation of chlorine dioxide gas. On the other hand, if the concentration exceeds 30 wt.%, there may occur a problem of saturation and subsequent

crystal deposition of chlorite. Therefore, in view of the safety and stability and efficiency of generation of chlorine dioxide gas, it is preferred that the concentration range from 0.1 to 30 wt.%.

[0023] According to a sixth characterizing feature of the chlorine dioxide generator of the present disclosure~~invention~~, the porous material is disposed closer to the gas discharge port than to the enclosure.

[0024] If the the porous material is disposed closer to the gas discharge port than to the enclosure as provided in the above arrangement, chlorine dioxide gas generated inside the container body can be discharged immediately via the gas discharge port to the outside of the container body. Hence, it becomes even easier to discharge a large amount of chlorine dioxide gas at one time (at one setting and in a transitory manner).

[0025] According to a seventh characterizing feature of the chlorine dioxide generator of the present disclosure~~invention~~, the generator further comprises an insulating member for insulating the porous material and the enclosure from each other, the insulating member having at least one hole portion and being disposed in such a manner as to be capable of preventing displacement of the porous material toward the enclosure.

[0026] With the above-described arrangement, since an insulating member is disposed between the porous material and the enclosure for preventing displacement of the porous material toward the enclosure, the porous material and the enclosure can be separated from each other in a reliable manner.

Further, since the insulating member is capable of preventing displacement of the porous material disposed closer to the gas discharge port than to the enclosure toward this enclosure, it becomes possible to allow the reaction for generating chlorine dioxide gas to take place on the side close to the gas discharge port in a reliable manner. With this, it becomes even easier to discharge a large amount of chlorine dioxide gas at one time (at one setting and in a transitory manner).

[0027] According to an eighth characterizing feature of the chlorine dioxide generator of the present disclosure~~invention~~, the container body includes a positioning means for setting movable range of the insulating member.

[0028] With the above-described arrangement, the range of movement of the insulating member inside the container body can be set in a reliable manner by the positioning means. With this, if e.g. the positioning means is used for setting the movable range of the insulating member in such a manner as to

prevent movement of the porous material toward the enclosure inside the container body, it becomes possible to allow the chlorine dioxide generation reaction to take place on the side close to the gas discharge port. With this, it becomes even easier to discharge a large amount of chlorine dioxide gas at one time (at one setting and in a transitory manner).

[0029] In another aspect, a~~A~~ccording to a characterizing feature of a method of producing chlorine dioxide relating to the present disclosure~~invention~~, the method comprises:

a gas generating step for generating chlorine dioxide gas by deforming the container body of the chlorine dioxide generator as disclosed herein~~according to any one of the first through eighth characterizing features~~; and

a submerging step for submerging in water at least the gas discharge port of the container body under the above condition of chlorine dioxide gas generation so as to dissolve the chlorine dioxide gas discharged via the gas discharge port in the water.

[0030] With the above, with utilizing the inventive chlorine dioxide gas generator capable of readily generating chlorine dioxide gas, simply by submerging at least the gas discharge port of the chlorine dioxide gas generator having generated chlorine dioxide gas in water stored in e.g. a water tank, an aqueous solution of chlorine dioxide can be produced easily.

BRIEF DESCRIPTON OF THE DRAWINGS

[0031] [Fig. 1] is a section view of a generator illustrating one embodiment of the present invention,

[Fig. 2] is a graph showing results of chlorine dioxide gas generation test of inventive Example 2,

[Fig. 3] is a graph showing results of chlorine dioxide gas generation test of inventive Example 3,

[Fig. 4] is a graph showing results of stability test of a sulfuric acid formulation of inventive Example 4,

[Fig. 5] is a section view of a generator illustrating a further embodiment of the present invention,

[Fig. 6] is a graph showing the result of investigation of difference in the generation amount depending on the charging position of a sulfuric acid formulation (silica gel),

[Fig. 7] is a graph showing the result of investigation of difference in the generation amount between a case where an acidic substance was carried

CLAIMS

[Claim 1] A chlorine dioxide generator configured to generate chlorine dioxide gas through a reaction between a chlorite and an acidic substance, the generator comprising:

a container body which is deformable in response to application of a force thereto from the outside;

wherein the container body includes a gas discharge port formed of a gas-permeable, water-impermeable or gas-permeable, water-permeation retardant member, the container body except for the gas discharge port being sealed, thus having a water-impermeable construction;

the container body contains therein a solid acidic composition and an aqueous chlorite solution under a non-contact condition from each other;

the solid acidic composition comprises a porous material containing an acidic substance that exhibits acidity when dissolved in water;

the aqueous chlorite solution is sealed within an easily breakable enclosure; and

when the container body is deformed, the enclosure contained therein is broken to bring the aqueous chlorite solution into contact with the solid acidic composition, whereby chlorine dioxide gas is generated and this chlorine dioxide gas is discharged via the gas discharge port to the outside of the container body.

[Claim 2] A chlorine dioxide generator configured to generate chlorine dioxide gas through a reaction between a chlorite and an acidic substance, the generator comprising:

a container body which is deformable in response to application of a force thereto from the outside;

wherein the container body includes a gas discharge port formed of a gas-permeable, water-impermeable or gas-permeable, water-permeation retardant member, the container body except for the gas discharge port being sealed, thus having a water-impermeable construction;

the container body contains therein a solid chlorite composition and an aqueous solution of an acidic substance under a non-contact condition from each other;

the solid chlorite composition comprises a porous material impregnated with an aqueous solution of chlorite;

the aqueous solution of acidic substance is sealed within an easily breakable enclosure; and

when the container body is deformed, the enclosure contained therein is broken to bring the aqueous acidic substance solution into contact with the solid chlorite composition, whereby chlorine dioxide gas is generated and this chlorine dioxide gas is discharged via the gas discharge port to the outside of the container body.

[Claim 3] The chlorine dioxide generator according to claim 1 or 2, wherein the container body is provided in the form of a flexible tube that can be flexed into an arcuate shape in response to application of the external force.

[Claim 4] The chlorine dioxide generator according to any one of claims 1-3, wherein said acidic substance comprises sulfuric acid and said chlorite comprises sodium chlorite or potassium chlorite.

[Claim 5] The chlorine dioxide generator according to any one of claims 1-4, wherein said acidic substance has a concentration of 30 wt.% or less and said chlorite has a concentration from 0.1 to 30 wt.%.

[Claim 6] The chlorine dioxide generator according to any one of claims 1-5, wherein the porous material is disposed closer to the gas discharge port than to the enclosure.

[Claim 7] The chlorine dioxide generator according to claim 6, wherein the generator further comprises an insulating member for insulating the porous material and the enclosure from each other, the insulating member having at least one hole portion and being disposed in such a manner as to be capable of preventing displacement of the porous material toward the enclosure.

[Claim 8] The chlorine dioxide generator according to claim 7, wherein the container body includes a positioning means for setting movable range of the insulating member.

[Claim 9] A method of producing chlorine dioxide comprising:

a gas generating step for generating chlorine dioxide gas by deforming the container body of the chlorine dioxide generator according to any one of claims 1-8; and

a submerging step for submerging in water at least the gas discharge port of the container body under the above condition of chlorine dioxide gas generation so as to dissolve the chlorine dioxide gas discharged via the gas discharge port in the water.

CLAIMS

[Claim 1] A chlorine dioxide generator configured to generate chlorine dioxide gas through a reaction between a chlorite and an acidic substance, the generator comprising:

a container body which is deformable in response to application of a force thereto from the outside;

wherein the container body includes a gas discharge port formed of a gas-permeable, water-impermeable or gas-permeable, water-permeation retardant member, the container body except for the gas discharge port being sealed, thus having a water-impermeable construction;

the container body contains therein a solid acidic composition and an aqueous chlorite solution under a non-contact condition from each other;

the solid acidic composition comprises a porous material containing an acidic substance that exhibits acidity when dissolved in water;

the aqueous chlorite solution is sealed within an easily breakable enclosure;

the porous material is disposed closer to the gas discharge port than to the enclosure;

the generator further comprises an insulating member for insulating the porous material and the enclosure from each other, the insulating member having at least one hole portion and being disposed in such a manner as to be capable of preventing displacement of the porous material toward the enclosure; and

when the container body is deformed, the enclosure contained therein is broken to bring the aqueous chlorite solution into contact with the solid acidic composition, whereby chlorine dioxide gas is generated and this chlorine dioxide gas is discharged via the gas discharge port to the outside of the container body.

[Claim 2] A chlorine dioxide generator configured to generate chlorine dioxide gas through a reaction between a chlorite and an acidic substance, the

generator comprising:

a container body which is deformable in response to application of a force thereto from the outside;

wherein the container body includes a gas discharge port formed of a gas-permeable, water-impermeable or gas-permeable, water-permeation retardant member, the container body except for the gas discharge port being sealed, thus having a water-impermeable construction;

the container body contains therein a solid chlorite composition and an aqueous solution of an acidic substance under a non-contact condition from each other;

the solid chlorite composition comprises a porous material impregnated with an aqueous solution of chlorite;

the aqueous solution of acidic substance is sealed within an easily breakable enclosure;

the porous material is disposed closer to the gas discharge port than to the enclosure;

the generator further comprises an insulating member for insulating the porous material and the enclosure from each other, the insulating member having at least one hole portion and being disposed in such a manner as to be capable of preventing displacement of the porous material toward the enclosure; and

when the container body is deformed, the enclosure contained therein is broken to bring the aqueous acidic substance solution into contact with the solid chlorite composition, whereby chlorine dioxide gas is generated and this chlorine dioxide gas is discharged via the gas discharge port to the outside of the container body.

[Claim 3] The chlorine dioxide generator according to claim 1 or 2, wherein the container body is provided in the form of a flexible tube that can be flexed into an arcuate shape in response to application of the external force.

[Claim 4] The chlorine dioxide generator according to claim 1 or 2,

wherein said acidic substance comprises sulfuric acid and said chlorite comprises sodium chlorite or potassium chlorite.

[Claim 5] The chlorine dioxide generator according to claim 1 or 2, wherein said acidic substance has a concentration of 30 wt.% or less and said chlorite has a concentration from 0.1 to 30 wt.%.

[Claim 6] The chlorine dioxide generator according to claim 1 or 2, wherein the container body includes a positioning means for setting movable range of the insulating member.

[Claim 7] A method of producing chlorine dioxide comprising:

a gas generating step for generating chlorine dioxide gas by deforming the container body of the chlorine dioxide generator according to claim 1 or 2; and

a submerging step for submerging in water at least the gas discharge port of the container body under the above condition of chlorine dioxide gas generation so as to dissolve the chlorine dioxide gas discharged via the gas discharge port in the water.