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(54) **Title**: METHOD AND APPARATUS FOR TREATING MICROBIAL CONTAMINATED AND/OR INFECTIOUS MATERIAL

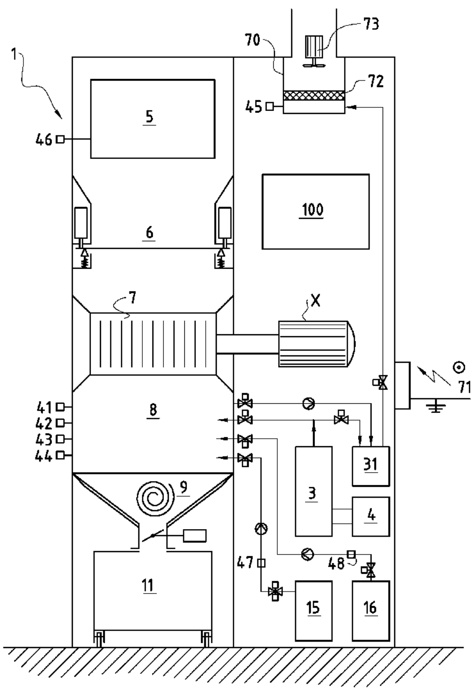

FIG. 4

(57) **Abstract**: The present invention relates to a method and a corresponding apparatus for treating microbial contaminated and/or infectious material in a chamber using a gas, comprising the following steps: - creating a vacuum in the chamber; - introducing an amount of gas into the chamber; and - monitoring the concentration of the gas in the chamber over time and, when a minimum predetermined value of concentration over time is reached, stopping introducing the gas into the chamber. The gas used can be ozone-enriched air.

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Method and apparatus for treating microbial contaminated and/or infectious material

Technical field of the invention

The present invention relates to a method and an apparatus for treating microbial contaminated and/or infectious material. More specifically, the present invention refers to the decontamination, disinfection, and sterilization of contaminated and/or infectious material such that this material, e.g. medical waste or other material used in chemical, pharmaceutical, or farm-produced industry, can be safely transported and disposed of.

Background of the invention

Increasing activities in the healthcare and research and development sectors have produced all sorts of used or disposable materials such as needles, scalpers, plastics, tubings, blood bags, various organic tissues, rubber gloves, masks and textiles. These used materials are exposed to pathogenic microbes and infectious virus as well as other organic and inorganic pollutants such as mold, mildew and spores. Similarly, other professions also constantly generate increasing quantity of materials which must be decontaminated, sterilized and/or disinfected before disposing these materials into environment in a safer manner.

These contaminated materials could be disposed using clinical hygienic big bags instead of expensive packaging containers for medical or clinical wastes from the medical treatment of animals or humans or from biological research originate. Currently, system containers for medical waste such as wound dressings, infectious waste, cytotoxic drugs, and organ waste have been used. The risk of infection during transportation must also be eliminated before they are disposed in an incinerator or in a controlled landfill site.

Numerous ways have been used in the past in an attempt to cope with this demand in order to decontaminate these contaminated materials, for example, through the above-mentioned method of waste incinerators, using chemical substances having antimicrobial properties, or using thermal treatment by steam generation. Apparatus for decontamination by means of ozone or an ozone-enriched gas have also been used. Such apparatus are especially suitable for decontamination or sterilization of medical waste close to the place of production.

Patent applications No. US 4 156 652 and US 5 087 419, for example, describe an apparatus which generally uses a closed circuit established between an ozone generator and a processing enclosure in which the waste to be processed is disposed. Some apparatus further provide means for injecting water or for stirring the gaseous environment or the waste, all with the object of facilitating the action of the ozone and improving its penetration. These measures as a whole can cause the chamber to operate under poor conditions since the flow of gas passing through them is humid and/or polluted by the processing enclosure and its contents.

Summary of the invention

Therefore, it is an object of this invention to provide a method and an apparatus for treating microbial contaminated and/or infectious material which do not have the above-mentioned drawbacks of prior art.

A particular object of this invention is to improve the effectiveness and/or rapidity of processing by improving and enhancing the penetration of ozone-enriched air onto the material to be treated. Also, it is envisaged that the amount of ozone necessary for treating the contaminated and/or infectious materials is minimized. Finally, another object of the present invention is to provide a safer working environment and reduce the risk of the workers to be harmed.

These and other objects of the present inventions are in particular achieved by means of a method for treating microbial contaminated and/or infectious material according to claim 1 and an apparatus for treating microbial contaminated and/or infectious material according to claim 12, the dependent claims defining more specific embodiments of the present invention.

In particular, the objects of the present invention are achieved by a method for treating microbial contaminated and/or infectious material in a chamber using a gas, comprising the following steps:

- creating a vacuum in the chamber;

- introducing an amount of gas into the chamber; and

- monitoring the concentration of the gas in the chamber over time and, when a minimum predetermined value of concentration over time is reached, stopping introducing the gas into the chamber.

The gas used can preferably be ozone-enriched air with various concentrations. Ozone has shown good properties in treating microbial contaminated and/or infectious material and is often is superior in sterilizing properties to other gases.

According to a preferred variant of the invention, the method comprises a further step of removing the gas from the chamber, this further step being carried out after the step of stopping introducing the gas into the chamber. Furthermore, it is also possible to destroy the gas. Certain hazardous gasses must be destroyed before they are released into the atmosphere. For example, if ozone gas is used, it can be converted into oxygen before releasing it into atmosphere. Other gasses can be neutralized or removed such that the chamber is ready and can be used for the next treatment.

According to one other preferred variant of the invention, the material to be treated is weighted, the amount of gas introduced into the chamber depending on the weight and/or on the degree of contamination and/or on the type of the material. For example, a minimum predetermined value of concentration over time can be adjusted accordingly based on those parameters so that gas wastage can be avoided while still being sufficient to treat and sterilize the contaminated material. Furthermore, the weighing of the material makes it possible to use the weight information as a cascade control input for giving an advance information to the system for an according adjustment of the amount of gas to be introduced into the treatment chamber.

According to another preferred variant of the invention, the method comprises a further step of introducing at least one further gas and/or liquid into the chamber, this further step being carried out before, simultaneously or after introducing the gas into the chamber. These further gases and/or liquids (also combinations or mixtures of them are possible) can be provided in form of vapor or steam or any other appropriate form. The order of steps in the sequence of introduction of the further gases and/or liquids depends essentially on the material to be treated, on the degree of contamination, or on the type of contaminants and can be chosen for optimizing the method.

In a preferred embodiment, the further gas and/or liquid is hydrogen peroxide. Hydrogen peroxide has antimicrobial properties which can namely be used in aqueous solution for disinfection and microbial control.

According to another preferred variant of the invention, the method comprises a further step of shredding and/or humidifying the material, this further step being carried out at any time prior to introducing the gas into the chamber. In addition, or alternatively, a further step of stirring the material is possible, this further step being carried out prior to introducing the material into the chamber at any time after introducing the gas into the chamber. All these additional steps allow the material to be treated to be exposed maximally to the treating gases and/or liquids during the treatment such that it can be penetrated easily and thoroughly by these treating gases and/or liquids. Moreover, humidifying the material (and/or the treatment chamber) can enhance the efficiency of the treatment by increasing the synergistic effect with the treating gas, namely ozone.

According to a further preferred variant of the invention, the method comprises a further step of rinsing the chamber, this further step being carried out prior to introducing the material into the chamber and/or after removing the material from the chamber. Rinsing the chamber is necessary to provide a clean and a sterilized chamber so that the chamber is ready and can be used for the next round of treatment.

If possible, the method can be carried out at a temperature of 5°C to 35°C, preferably at room temperature. These temperatures are proven to be particularly suitable for treating the microbial contaminated and/or infectious material. The temperature of the treatment chamber can play an important role in the treatment efficiency. For example, a higher temperature implies that the ozone reaction is more aggressive. There are however some practical reasons to limit the temperature range. It is therefore preferred that the temperature is being monitored during the carrying out of the method according to the present invention in order to compensate the effects of the temperature by adjusting the treatment cycle and duration.

Finally, the step of introducing of gas into the chamber can preferably be carried out continuously until the minimum predetermined value of concentration of the gas over time is reached. In this way, the concentration of the treating gas in the chamber can be kept high, enhancing thereby the efficiency of the treatment by reducing the contact time between the material to be treated and the treating gas.

According to another aspect of the present invention, there is provided an apparatus for treating microbial contaminated and/or infectious material using gas, comprising:

- at least one treatment chamber;

- at least one gas generator and/or gas storage means for introducing the gas into the at least one treatment chamber; and

- at least one monitoring means for measuring and/or monitoring the concentration of the gas in the treatment chamber over time and, when a minimum predetermined value of concentration over time is reached, stopping introducing the gas into the treatment chamber.

According to some preferred variants of the present invention, the apparatus can further comprise at least one weighing means and/or additional monitoring means like sensors for detecting temperature, radioactivity and humidity. The parameters generated by these means or sensors can allow for a safe and efficient treating process.

Brief description of the drawings

In the following description, various embodiments of the invention are described with reference to the following drawings (the drawings not necessarily being drawn to scale, emphasis instead generally being placed upon illustrating the principles of various embodiments):

- Figure 1 is a diagram illustrating a method of treating microbial contaminated and/or infectious materials according to one embodiment of the present invention;

- Figure 2 is a graph illustrating gas concentration (residual disinfectant concentration, in mg/l or PPM) over contact time in prior art compared to the increased efficiency of the present invention;

- Figure 3 is a diagram illustrating a method of treating microbial contaminated and/or infectious materials according to another embodiment of the present invention; and

- Figure 4 is a schematic representation of an apparatus for treating microbial contaminated and/infectious material according to one embodiment of the present invention.

Detailed description of the present invention

In the following a new method and apparatus for treating microbial contaminated and/or infectious material according to preferred embodiments of the present invention will be described.

Figure 1 is a diagram illustrating one embodiment of the method according to the present invention. This method is generally characterized by the fact that the concentration of the gas which is used in order to treat the material is monitored over time and that the treatment is carried out until a minimum predetermined value of gas concentration over contact time is reached. More specifically, once the material to be treated has been introduced into the treatment chamber, and then a vacuum condition is created in the chamber in step 54. Then, an amount of gas is introduced into the chamber in step 56. At the same time, the change of the concentration of this gas is constantly monitored over a period of time in step 59. During this monitoring phase, once a certain threshold is reached, the flow of gas which is introduced into the chamber is stopped in step 60. However, if the minimum predetermined value of the threshold is not reached, the gas will continuously be fed into the chamber according to the step 56. It is also noteworthy that the amount of gas which is introduced into the treatment chamber can depending on a number of criteria, for example on the total weight and/or the degree of contamination and/or the type of the material to be treated. Through this adjustable measurement, a threshold value can be set accordingly, therefore no gas is wasted unnecessarily. An efficient sterilization process can hence be achieved.

The threshold value is determined on the basis of the so called CT-value (i.e. concentration * time). This CT-value is generally used to characterize the disinfection of pathogenic microbes and viruses and it basically corresponds to the “residual disinfectant concentration over contact time”. Thus, the term CT-value relates to the product of the “residual disinfectant concentration” (C) in mg/l, and the corresponding “disinfectant contact time” (T) in minutes or seconds. For example, the CT-value for ozone can be calculated as the ozone concentration in the air multiplied by the contact time. In actual fact, sanitizing treatments with ozone (or any other gas) can sometimes be accomplished very quickly, but some treatments will require sufficient ozone in the air along with an adequate contact time. This contact time is required for the dissolved ozone to oxidize organic contaminants and to disinfect the treated material. Therefore, either the concentration can be held constant while the time is varied, or visa-versa, to assure that a given level of disinfection is obtained. For example, if a CT-value of 1.6 is required (for example in the treatment of a particular contaminated material), the dosage rate of ozone needs to be 1.6 mg/l in a particular time interval. Therefore, the material can be exposed to ozone at 0.2 mg/l (also called PPM) during 8 minutes or at 0.4 PPM during 4 minutes.

Coming back to the method according to the present invention, the concentration of gas in the treatment chamber can be monitored in a continuous manner or until a predetermined CT-value has been reached, when the flow of gas is stopped. Then, the material can be unloaded from the treatment chamber. Otherwise, the flow of gas into the chamber is maintained until this predetermined CT value is reached in step 60. Therefore, in some examples, higher gas concentration is preferably used in order to shorten the disinfectant contact time. Moreover, temperature in the treatment chamber can also have a correlation with the CT value. For example, a room temperature of the treatment chamber of around 21 °C is preferably selected according to a variant of the present invention. When the temperature in the treatment chamber increases, the CT value can be maintained at the same level or even lowered. Contrarily to this, when the temperature in the treatment chamber decreases, a higher CT value is required. In other words, a higher minimum predetermined CT value is required in this case.

Conventional apparatus using gas for treating microbial contaminated and/or infectious material typically injects a predetermined amount of gas at predetermined intervals, i.e. not in a continuous manner, into the treatment chamber, regardless of the amount, the degree of contamination or the type of the material to be treated. As a consequence, a large amount of gas is wasted unnecessarily.

Figure 2 nicely illustrates a superior efficiency of the present invention (illustrated with dotted lines, C1, C2, C3…) compared to the prior art apparatus and method (illustrated with full lines, B1, B2, B3…) used in treating microbial contaminated or infectious materials. Figure 2 specifically shows the changes of gas concentration (mg/l, PPM) over contact time (T). As the injected active gas continuously reacts with the materials, said gas slowly degrades over time, and hence the gas concentration is slowly reduced over time. Contrarily to this, the gas concentration in conventional apparatus decreases quickly over time, thereby resulting in a very low concentration before a new boost of the treatment gas is injected into the chamber to pump up again to high gas concentration (t_1, t_2, t_3, t_4). This in turn causes the increasing of disinfectant contact time, and hence slows down the overall performance.

The present invention aims to minimize gas wasting, hence a minimal yet sufficient amount of gas is introduced into the chamber which can for example depend on the weight and/or on the degree of contamination of the material. Further, an amount of gas is constantly introduced into the treatment chamber in order to keep a high gas concentration in the chamber, thus maintaining a high reacting performance. Moreover, the gas concentration in the chamber is constantly monitored over time such that the flow of gas can be interrupted after the minimum CT-value threshold has been reached. Given that the gas is constantly fed into the treatment chamber and that it can advantageously be maintained at a high concentration, a more efficient sterilization treatment can be realized. In addition, this can also significantly reduce disinfectant contact time compared to the methods known from the prior art. Furthermore, monitoring of the gas concentration in the chamber and stopping the gas flow after the sterilizing has been carried out, advantageously allows for a minimal amount of treatment gas to be used and hence, also to increase the treatment efficiency and to reduce wasting.

In addition, the treatment chamber can be kept constantly under a lower pressure (e.g. 0.3 to 0.6 Bar) compared to the higher pressure of the gas source (i.e. a gas generator having a pressure of around 1.1 to 2.2 Bar) such that due to the pressure difference, the treatment gas is urged to flow from high pressure gas generator to the low pressure treatment chamber. Through this setting, the flow of gas into the treatment chamber can be easily controlled.

Figure 3 illustrates an example of the method for treating microbial contaminated and/or infectious material according to another embodiment of the present invention. The method according to this embodiment comprises a number of additional steps when compared to the method illustrated in Figure 1.

Microbial contaminated and/or infectious material to be treated is first loaded into the processing or treatment chamber in step 51. The material is then weighed in step 52, before a shredding step 53 is carried out in order to shred the material into smaller pieces, therefore increasing the surface of the material and enhancing the efficiency of the treatment. Thereafter, a vacuum is created in the chamber in step 54. The vacuum for the purpose of this application means that a substantial part of the air is removed from the treatment chamber, creating thereby a lower pressure and simplifying the introduction of the treatment gas in all cavities of the waste. Moreover, it is noteworthy that by creating a lower pressure (such as vacuum or nearby vacuum condition), this not only increases the gas concentration according to the formula which will be explained in more detailed below ($C_N = C_1(T_1/p_1)$ x (1013.25 mbar / 273.15 K) but also diffusion in liquids.

. In the next step 55, the material in the chamber is humidified for example with water and/or hydrogen peroxide and afterwards, ozone-enriched air is introduced into the chamber in step 56. During the interaction of the material with ozone gas, the shredded material could be stirred in a stirring step 57, while further gases and/or liquids are added into the chamber in step 58 (e.g. hydrogen peroxide). The addition of hydrogen peroxide could enhance an overall sterilization treatment process.

According to this embodiment of the present invention, a constant amount of ozone-enriched gas is continuously fed into the treatment chamber such that a high concentration of ozone-enriched gas can be reached. As ozone gas is highly unstable with short half-life, continuous flow of ozone-enriched gas is preferably provided to render high efficiency of sterilization and decontamination process. The high concentration of ozone gas provided could thereby reduce the disinfectant contact time. Furthermore, the change of the concentration of the ozone gas is constantly monitored in step 59, for example using various monitoring means, sensors and a programmable logic controller which can be controlled in situ or ex situ.

An ozone CT-value can be determined depending on the material to be treated such as the type of the material, the degree of contamination, the weight of the material or the specific contaminants exposed on the material. For example, lower degree of contamination of materials is considered to be found on mask, gloves, tubings etc. used for daily routine. Higher degree of contamination presents material which is largely contaminated by organic pollutants during usage and/or which has been kept for a longer period (for example at least a week) before being treated for sterilization. Spores, microbes and other infectious contaminants can be grown on the contaminated material. Therefore, this categorization can for example be used to set a suitable CT-value and then use it to control the method in step 60 in that, when this predetermined minimum CT-value of ozone is reached, the flow of the ozone-enriched air is stopped. Otherwise, while this minimum predetermined ozone CT-value has not been reached, a constant flow of ozone-enriched air is maintained until reaching the CT-value. The ozone concentration can namely be set in between 5 and 100 mg/l or even more preferably in between 12 and 25 mg/l.

Ozone concentration [g(O_3)/Nm^3] or [mg/l] can be calculated using the following formulas:

A Nm^3 (normal cubic meters) is a cubic meter of respective sample gases under normal conditions, defined as T = 273.15 K (= 0°C) and p = 1013.25 mbar.

$C_N = C_1(T_1/p_1) \times (1013.25\ \text{mbar} / 273.15\ \text{K})$ with T_1 in Kelvin and p_1 in mbar

Or when the usage of T_1 is in °C:

$C_N = [C_1 \times (1013.25 + 3.71 \times T_1)]/p_1$ with T_1 in °C and p_1 in mbar.

Once the flow of ozone-enriched air is stopped using automatic-controlled valve, for example, the remaining ozone gas in the treatment chamber can be evacuated (and eventually destroyed before being released into the atmosphere) and the chamber can be rinsed in step 61 with other disinfectant or chemical substances before unloading the treated materials in step 62.

Figure 4 illustrates an example apparatus 1 according to a preferred embodiment of the present invention, where ozone is used as treating gas.

A number of individual, smaller chambers 5, 6, 8, 9, 11 can be found within the chamber 1. Microbial contaminated and/or infectious material to be treated is first loaded into a loading chamber 5. If necessary, a radioactivity sensor 46 can be installed to monitor whether the material to be treated has been contaminated by radioactivity. This material (e.g. disposable material from a hospital) is then weighed using a weighing means (e.g. a conventional balance) 6 before being shredded by a shredder 7, actuated by a motor X. During the shredding process, gas and/or liquid such as water and/or hydrogen peroxide (H_2O_2) could be fed from independent boost tanks 15, 16 into the treatment chamber 8 in order to enhance the treating reaction of ozone with the material. Hydrogen peroxide is generally known to have antimicrobial properties and has been used in aqueous solution for example for disinfection and microbial control. Furthermore, the humidity of the chamber also plays a role in enhancing the reaction of ozone. For example, a relative humidity of 90% to 98% in the treatment chamber is foreseeable in the present invention. Preferably, a relative humidity of about 95% in the treatment chamber could be used to enhance the ozone effect. In another variant, it is preferably that the material to be treated is humidified with water instead of humidifying the chamber air, as extremely high humidity of the chamber air may hinder ozone reaction.

A programmable logic controller 100 such as computer micro controller can be involved in monitoring the changes of gas concentration in the treatment chamber 8 over time. A number of monitoring means 41, 42, 43, 44, 45, 46, 47, 48 such as thermometer, pressure gauge, humidity sensor, ozone sensor, radioactivity sensor, oxygen sensor and hydrogen peroxide sensor can be used to assist in detecting the changes of condition of the treatment chamber 8. These monitoring means and/or sensors are generally connected to the programmable logic controller 100 and send signals which can be used by the controller 100 in order to control the flow of ozone into the chamber 8 and other steps of the process. Once the process has been stopped, i.e. the flow of ozone has been stopped, the treated material can be moved by a worm drive 9 and an agitator into an unloading chamber 11 before being unloaded and safely transported and disposed of.

The remaining ozone gas in the treatment chamber 8 is then first destroyed using an ozone destroyer 31 before it is released into the atmosphere through a chimney 70. A filter 72, preferably a HEPA filter, is used to filter the gas before it is pumped out 73 into the external environment. An ozone-detecting sensor can be installed at the chimney 70 to detect minute quantity of ozone which is released into the outer atmosphere. In general, the remaining ozone air safe to be released into environment would contain less than 0.06 ml/m3 (0.12 mg/m3) according to the international standards.

The ozone which is fed into the treatment chamber 8 can be stored in an ozone tank. However, according to this preferred embodiment, this ozone tank has been excluded due to safety concern. Namely, it has been reported that ozone tanks are prone to explosion when mishandled. Instead, an ozone generator 3 is preferably used to provide constant flow of ozone gas into the treatment chamber 8. A number of valves and pumps can be seen in the Figure 4. . Furthermore, monitoring means like sensors 47, 48 can be found therein to monitor the flow of gas and/or liquid such as hydrogen peroxide and water for example. Importantly, as ozone gas is highly unstable and has a short half-life, in order to maintain the ozone concentration in a constantly high level, an oxygen generator 4 can also be used to constantly provide oxygen gas into the ozone generator 3. Of course, use of the ozone generator 3 does not preclude use of an ozone tank can be used.

The apparatus 1 can particularly be connected to an electric connection equipped with a safety button 71. The apparatus can also be controlled manually or automatically from a remote location or by means of a controller on site. Further, as the material can be weighed according to one variant of the present invention, hence a report on the decontaminated waste can be generated and a certificate of proper microbiological decontamination of waste based on the successful achievement of the CT-value can be provided to customers. In addition, preventive maintenance by monitoring all parameters can also be offered.

Furthermore, according to another embodiment of the present invention, the monitoring means are capable of monitoring a number of other parameters. For example, the ozone concentration within the apparatus (but outside the treating chamber), the ozone concentration in the atmosphere outside the apparatus, pressure in the ozone tank, pressure in the loading chamber, and concentration of ozone in the treatment chamber can also be monitored.

Claims

1. A method for treating microbial contaminated and/or infectious material in a chamber using a gas, comprising the following steps:

- creating a vacuum in the chamber;

- introducing an amount of gas into the chamber; and

- monitoring the concentration of the gas in the chamber over time and, when a minimum predetermined value of concentration over time is reached, stopping introducing the gas into the chamber.

2. The method according to claim 1, comprising a further step of removing the gas from the chamber, this further step being carried out after the step of stopping introducing the gas into the chamber.

3, The method according to claim 1 or 2, wherein the material to be treated is weighted, the amount of gas introduced into the chamber depending on the weight and/or on the degree of contamination and/or on the type of the material.

4. The method according to any one of the preceding claims, wherein the gas is ozone-enriched air.

5. The method according to any one of the preceding claims, comprising a further step of introducing at least one further gas and/or liquid into the chamber, this further step being carried out before, simultaneously or after introducing the gas into the chamber.

6. The method according to claim 5, wherein the further gas and/or liquid is hydrogen peroxide.

7. The method according to any one of the preceding claims, comprising a further step of shredding and/or humidifying the material, this

further step being carried out at any time prior to introducing the gas into the chamber.

8. The method according to any one of the preceding claims, comprising a further step of stirring the material, this further step being carried out prior to introducing the material into the chamber at any time after introducing the gas into the chamber.

9. The method according to any one of the preceding claims, comprising a further step of rinsing the chamber, this further step being carried out prior to introducing the material into the chamber and/or after removing the material from the chamber.

10. The method according to any one of the preceding claims, the method being carried out at a temperature of 5°C to 35°C, preferably at room temperature.

11. The method according to any one of the preceding claims, the step of introducing of gas into the chamber being carried out continuously until the minimum predetermined value of concentration of the gas over time is reached.

12. An apparatus (1) for treating microbial contaminated and/or infectious material using gas, comprising:

- at least one treatment chamber (8);

- at least one gas generator (3) and/or gas storage means for introducing the gas into the at least one treatment chamber (8); and

- at least one monitoring means (41, 42, 43, 44) for measuring and/or monitoring the concentration of the gas in the treatment chamber (8) over time and, when a minimum predetermined value of concentration over time is reached, stopping introducing the gas into the treatment chamber (8).

13. The apparatus according to claim 12, further comprising a weighing means (6) for weighing the material to be treated.

14. The apparatus according to claims 12 or 13, wherein the gas is ozone-enriched air.

15. The apparatus according to any one of claims 12 to 14, comprising means (15, 16) for introducing at least one further gas and/or liquid into the treatment chamber (8), the further gas and/or liquid being preferably hydrogen peroxide.

16. The apparatus according to any one of claims 12 to 15, comprising a shredder (7) for shredding the material to be treated and/or a stirrer for stirring the material to be treated.

17. The apparatus according to any one of claims 12 to 16, wherein the at least one monitoring means (41, 42, 43, 44) comprise a thermometer, a pressure gauge, a humidity sensor, an ozone sensor, a hydrogen peroxide sensor and/or a radioactivity sensor.

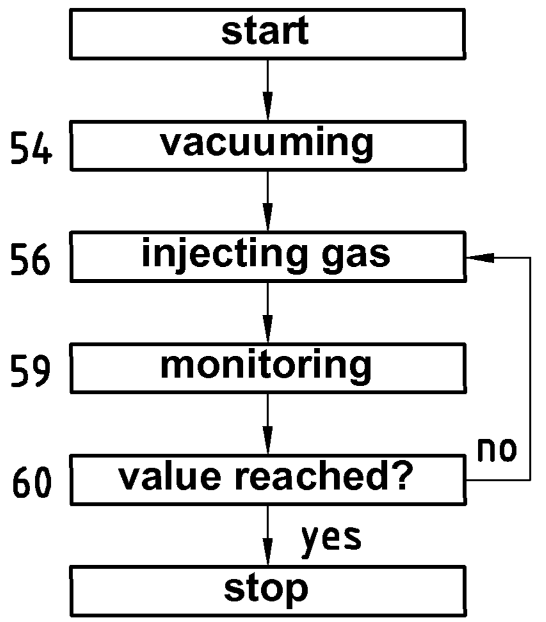
start
54
vacuuming
56
injecting gas
59
monitoring
60
value reached?
no
yes
stop

FIG. 1

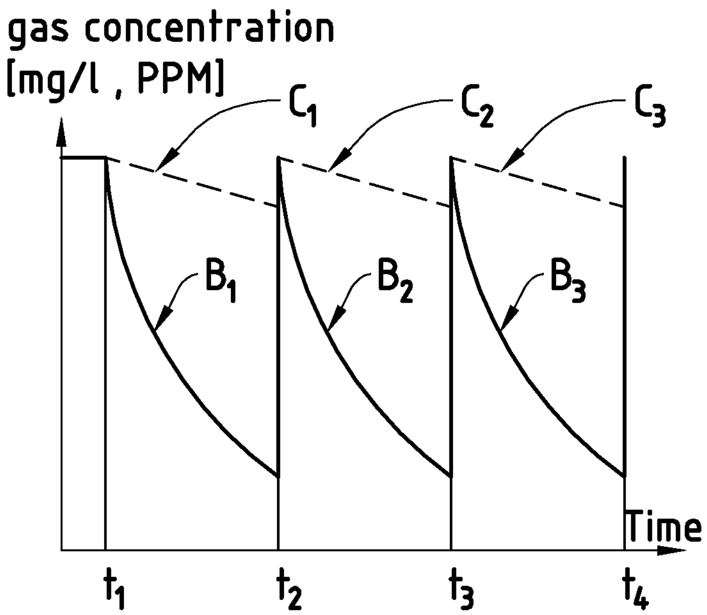
gas concentration
[mg/l , PPM]
C1
C2
C3
B1
B2
B3
Time
t1
t2
t3
t4

FIG. 2

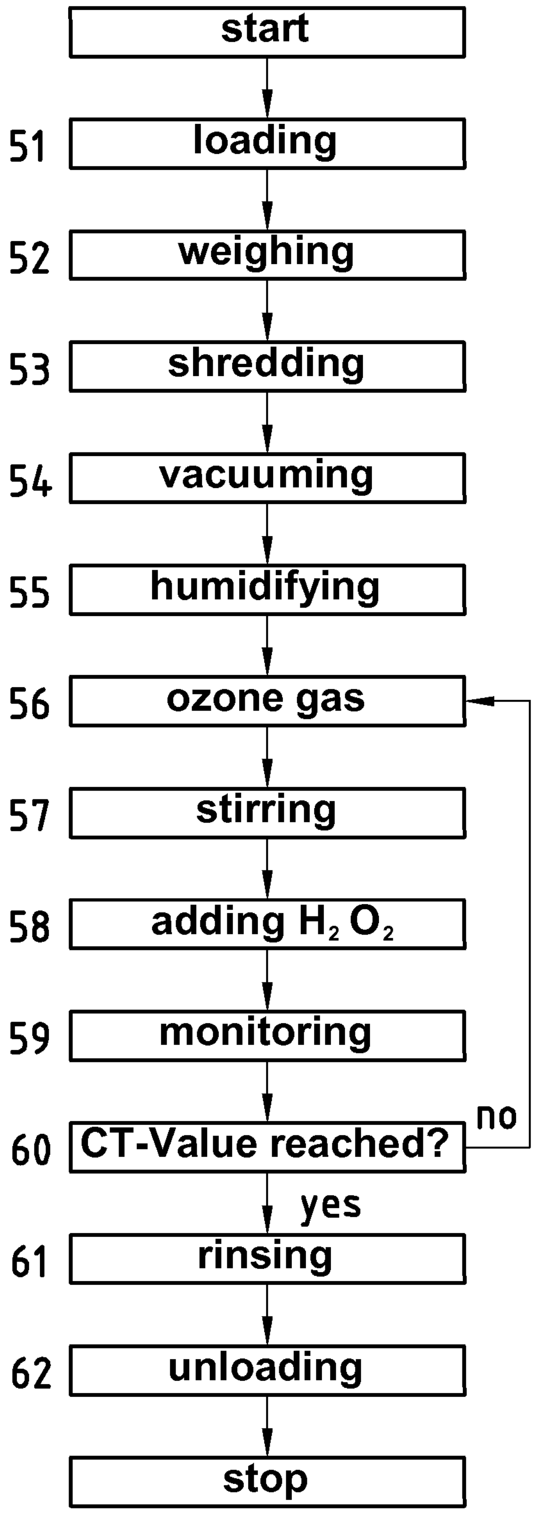
start
51 loading
52 weighing
53 shredding
54 vacuuming
55 humidifying
56 ozone gas
57 stirring
58 adding H_2O_2
59 monitoring
60 CT-Value reached?
no
yes
61 rinsing
62 unloading
stop

FIG. 3

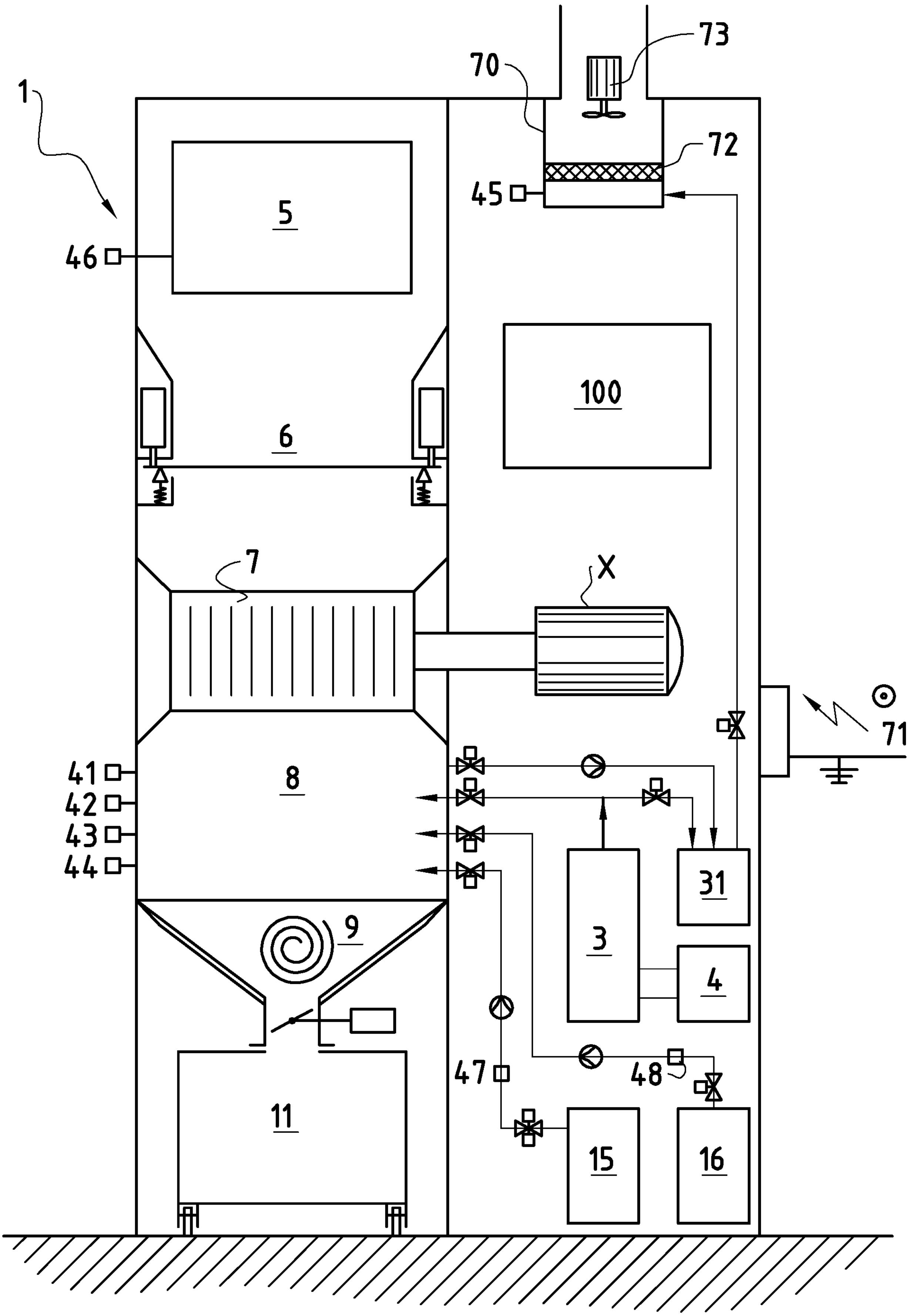

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/051592

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61L11/00 A61L2/20 A61L2/24
ADD.

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)
A61L

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2005/097215 A1 (KLAPTCHUK PETER [CA]) 20 October 2005 (2005-10-20)	1,2,4,5, 7,8, 10-12, 14-17
Y	page 8, line 7 - page 13, line 14; figures 1-3	1-17

X	US 2015/139854 A1 (JUDE PETER A [US] ET AL) 21 May 2015 (2015-05-21)	1,2,4,5, 7-11
Y	paragraphs [0018] - [0032], [0037] - [0045]; figure 1	1-17

Y	JP H05 115540 A (AGENCY IND SCIENCE TECHN; NIPPON MEDICS KK) 14 May 1993 (1993-05-14) abstract	1-3,6, 10-13,17

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 March 2016	18/03/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Katsoulas, K

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	JP H11 226579 A (MITSUBISHI ELECTRIC CORP) 24 August 1999 (1999-08-24) abstract -----	3,5,6, 13,15
A	US 5 951 948 A (DUROSELLE PATRICK [FR] ET AL) 14 September 1999 (1999-09-14) column 3, line 63 - column 5, line 8; figure 1 column 5, line 59 - column 6, line 3 -----	1,2,4,5, 7-10,12, 14-17

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2016/051592

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