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(54) **METHOD AND APPARATUS TO REDUCE WASTE PRODUCTION IN AN ISOLATION PROCESS**

VERFAHREN UND VORRICHTUNG ZUR ABFALLREDUZIERUNG IN EINEM ISOLIERUNGSVERFAHREN

METHODE ET APPAREIL POUR REDUIRE LA PRODUCTION DE DECHETS DANS UN PROCEDE D'ISOLEMENT

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a method and an apparatus for reducing the amount of waste, requiring special handling and possible destruction, produced in an isolation process involving vaporization, in an evaporator apparatus, of a water solution containing environmentally hazardous substances, wherein

- a considerable amount of the water content is vaporized by heating in at least one reusable vaporization chamber,
- the water content of said water solution being vaporized into vapor, which is released, possibly after condensation into water, to an ambient system, and
- the vaporization process is stopped at a certain time, at which the remaining water solution is removed from said at least one reusable vaporization chamber for further processing.

BACKGROUND OF THE INVENTION

[0002] Generally, there are several types of substances that may be unsuitable or harmful in the environment (environmentally hazardous substances). Some may be harmful to animals via a specific mechanism (such as hormones that may influence the normal reproduction of marine animals), others may be generally toxic (such as cytostatic drugs) while, in the case of antibiotics and antiviral drugs, there may be an increased risk for development of resistant bacteria and viruses if the environment contains antibiotics and antiviral drugs for a substantial amount of time. Environmentally hazardous substances include antibiotics, antifungal and antiviral drugs, NSAID (non-steroid anti-inflammatory drugs), cytostatic drugs, hormones (such as steroid hormones), antidepressants, antipsychotics, and many other pharmaceutical or non-pharmaceutical substances.

[0003] Today, much pharmaceutical and biotech research is performed on cells from cultures that grow for a varying amount of time in a medium. In order to prevent bacterial infections which can destroy cell cultures, various types of antibiotics are often added to the growth medium. See "The prophylactic use of antibiotics in cell culture", Ingrid Kuhlmann, Cytotechnology (1995), pp 95-105. When the cell culture is discarded, it is important to prevent that the antibiotics from the cell culture is released to the environment, which could enhance development of antibiotic resistant bacteria. This may be achieved by heating of the growth medium during autoclaving, if the substances being used are thermosensitive. However, many antibiotics and other hazardous substances are not sufficiently degraded by this process, and it may therefore be necessary to incinerate the substances in a high temperature oven instead. This can be problematic e.g. in a research institute that can generate very substantial amounts of liquid polluted with antibiotics every day. The disposal of large quantities of waste such as growth media and other liquids with environmentally hazardous substances such as antibiotics to suitable high temperature incinerators can result in high financial costs as well as logistic problems. Therefore, it is desirable to reduce the amount of waste that has to be destroyed to a minimum.

[0004] The process of vaporization is widely used to concentrate foods and chemicals as well as to salvage solvents. A solution containing the desired product is fed into the evaporator and passes across a heat source in a reusable vaporization chamber. The applied heat converts the water in the solution into vapor. The vapor is removed from the rest of the solution and is normally condensed before being released, while the now-concentrated solution is either fed into a second evaporator or is removed. An evaporator apparatus used in the present invention generally consists of four units:

- a liquid receiving unit for receiving the water solution,
- at least one reusable vaporization chamber for heating the water solution so as to vaporize water from said water solution,
- a vapor evacuation unit, and
- a vapor releasing unit, e.g. a condensation unit, which is connectable to an ambient system, such as a sewage system, for releasing vapor or condensed water during the vaporization process.

[0005] Evaporators can also be used to isolate environmentally hazardous substances which are dissolved in water solutions. An initial vaporization process removes much, but not all, of the water. The removed vapor, or water if a condensation unit is used, can be released into an ambient system, e.g. directly into the ambient air, a sewage system, a water tank or even a ditch. The remaining solution in the reusable vaporization chamber contains the hazardous substances, and can subsequently be taken care of for instance by destruction in an incinerator. This eliminates a potential environmental hazard.

[0006] However, there are considerable problems with this method.

[0007] Vaporization of the water solution results in fouling with hard deposits on the surfaces of the vaporization chamber, especially when a large portion of the liquid has been vaporized and the concentration of the solvents therefore has increased. It may require costly and labor-intensive cleaning to remove these deposits, or it may even require a replacement of the soiled unit. Another problem with removing much water in the reusable vaporization chamber is that the viscosity of the water solution will gradually increase, which will make it increasingly difficult to transfer the water residue to a waste container. Therefore, before all of the water has been vapor-

ized in the vaporization chamber, the vaporization process is stopped at a certain time, at which the remaining solution in the evaporator is removed from the reusable vaporization chamber for handling as waste and possible destruction. Accordingly, the present method of isolation of substances that are dissolved in water solutions necessarily results in the production of considerable amounts of waste material, which is uneconomic and cause logistic problems.

[0008] Document US 3 733 617 A discloses an evaporator apparatus of the prior art for vaporization of a water solution containing environmentally hazardous substances.

OBJECT OF THE INVENTION

[0009] Against this background, the object of the invention is to substantially reduce the amount of waste that is produced when environmentally hazardous substances are isolated from water solutions using vaporization. The reusable vaporization chamber of the evaporator apparatus should preferably be reusable for a number of further vaporization processes.

SUMMARY OF THE INVENTION

[0010] The method according to the invention involves a two-stage or multi-stage removal of water from a water solution with dissolved environmentally hazardous substances, with the intention of isolating and destroying the dissolved substances, with the first removal of water occurring in one or a number of reusable evaporators and the final removal of water occurring in one or more waste isolating containers. The advantage of performing the final reduction of water in a waste isolating container is that at this point it does not matter if dissolved substances cause deposits on the walls, and has a high viscosity, because this container is not reusable, but is instead normally sent for destruction.

[0011] This two-stage or multi-stage reduction with the final reduction of water occurring in the waste isolating container will substantially reduce the total production of waste from the evaporator apparatus.

[0012] According to the present invention, a method and an evaporator apparatus are provided that will substantially reduce the amount of produced waste containing environmentally hazardous substances, wherein:

- said certain time, at which the first removal of water occurring in one or a number of reusable evaporators is stopped, is adjusted so that the water content is reduced by 30% to 95%, and the remaining water content is 70% to 5% of the initial water content, the remaining water content resulting in the formation of only minor deposits in said at least one reusable vaporization chamber, and allowing an easy removal of the remaining water solution (waste) from the reusable vaporization chamber;
- said remaining water solution (waste), at said certain time, is transferred from said reusable vaporization chamber into at least one waste isolating container;
- whereupon said remaining water solution (waste) in said at least one waste isolating container is subjected to at least one further water-reducing process by heating, where the water content in said at least one waste isolating container is further reduced by 10% to 100%,
- the combined water-reduction in said at least one reusable vaporization chamber and said at least one waste isolating container being such as to leave a final water content in said at least one waste isolating container of 10 % to 0 % of the initial water content of said water solution containing environmentally hazardous substances;
- the remaining waste in said at least one waste isolating container, including said environmentally hazardous substances, is left in said separate waste isolating container for separate handling;
- when the waste has reached a specified level in the at least one waste isolating container, the at least one waste isolating container is taken away and replaced; and
- the at least one waste container containing the waste is subjected to a destructive treatment, such as incineration

[0013] The term "reusable" vaporization chamber depicts that the vaporization chamber is refilled at least once to be used during two or more vaporization processes before being discarded.

[0014] A somewhat similar process is disclosed in the document US 4,132,640 (von Rool AG). This system will provide for processing a water solution containing salt and organic substances. The water solution is fed into an evaporator, which will remove water vapor. The remainder is led to a spray dryer, where hot flue gases will cause a further vaporization. The separated substance is then led to a combustion chamber forming part of a continuously operating system. The resulting flue gases are fed via a pipe to a boiler and then to a filter, from which the gases are discharged into the atmosphere through a pipe and a chimney. Accordingly, this prior art system is an integrated evaporization and combustion system, and there is no isolation of the waste in a replaceable waste isolating container, as in the present invention.

BRIEF DESCRIPTION OF THE DRAWING

[0015] The invention will now be described in more detail with reference to the appended drawing with a single

figure showing schematically an evaporator apparatus according to the present invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

[0016] The evaporator apparatus used in a preferred embodiment of this invention comprises a liquid receiving unit 1, an inlet valve V1, a vaporization unit 2 provided with a vaporization chamber 2a, a number of heating elements 2b, 2c, 2d placed outside but in contact with the metal walls of the chamber 2a, sensors 2t, 2p, 2l for determining the temperature, pressure and level of contents in the vaporization chamber, respectively, a vapor evacuation unit 3 with an associated valve V2, a vapor condensation unit 4 provided with a cooling water inlet 4a, an associated valve V3 and a cooling water outlet 4b, an outlet valve V4, and a pump 5 for reducing the pressure below the atmospheric pressure in the vaporization chamber 2a. In principle, these components form a prior art evaporator apparatus. As is also previously known, there may be at least one further reusable vaporization chamber (not shown) in the vaporization unit 2 for removal of liquid in consecutive steps.

[0017] According to the invention, at least one waste isolating container 6 is connected, via a valve V5, to the vaporization chamber 2a. This waste isolating container 6 (or two or more waste isolating containers to be used one at a time, possibly after switching the connection) is used for receiving waste generated in the vaporization unit 2, and in this waste isolating container further water is removed from the waste material. The waste isolating container is also connectable to the pump 5 via a valve V6. The waste isolating container 6 is used only until the waste has reached a specified level, at which time the waste isolating container is considered to be full and is replaced. At this point the waste isolating container will be taken away from the evaporator apparatus and normally sent to destruction, e.g. in an incinerator or high temperature oven (not shown).

[0018] The apparatus operates as follows below, it being understood that a computer (not shown) is used to control the whole process on the basis of signals received from various sensors, e.g. the above-mentioned temperature sensor 2t, pressure sensor 2p and level sensor 21, preferably disposed inside the vaporization chamber 2a, and a temperature sensor 6t, a pressure sensor 6p and a level sensor 61, preferably disposed in the waste isolating container 6, and also on the basis of control signals being sent to the various valves V1, V2, V3, V4, V5 and V6. In addition, one or more pumps are used to move the water solutions to the appropriate compartment, as well as being able to reduce the ambient pressure in the vaporization chamber 2a and the waste isolating container 6 to facilitate formation of water vapor through vaporization.

[0019] A batch of a water solution, containing environmentally hazardous substances, such as antibiotics or other hazardous substances, is fed into the liquid receiving unit 1 and to the reusable vaporization chamber 2a. There, the water solution is heated by the heating elements 2b, 2c, 2d so that water will vaporize and form vapor in the vaporization chamber 2a. The vapor is evacuated via the vapor evacuation unit 3. Thereafter, the vapor is circulated through the vapor condenser unit 4 by means of the pump 5. The condensed water is released into a regular sewage system, a water tank or even a ditch. Alternatively, the vapor can be let out for instance into the ambient air or into a water tank or to the sewage system without first being condensed into water.

[0020] The level sensor 2l detects the amount of water solution containing environmentally hazardous substances that is fed into the evaporator, and the vaporization process is continued, by means of the heating elements 2b, 2c, 2d, until the desired percentage of water has been removed from the solution.

[0021] The vaporization process in the vaporization chamber is stopped at an optimum time, when the remaining water content is still high enough to secure that there is a sufficient fluidity of the solution and that there is only a small tendency for formation of deposits on the walls of the vaporization chamber 2a, but the water content being as small as possible. The tendency to form deposits on the walls of the vaporization chamber differs between different water solutions, and has to be determined in preliminary examinations for all water solutions that are fed into the evaporator. At the optimum time, the vaporization process in the vaporization unit 2 is stopped, and the remaining, more concentrated water solution is transferred via the valve V5 to the waste container 6. Here, the water content of the water solution is reduced further, preferably by means of a heating plate 6a, possibly provided with a thermostat (not shown) set at a desired temperature, placed underneath the waste isolating container 6. The further reduction of water in the waste isolating container is continued until 10% to 100% of the remaining water content has been removed.

[0022] Alternatively, there may be many other ways to heat the contents in both the vaporization chamber and the waste isolating container, including using heating elements at least partially immersed in the liquid, microwaves, induction and many more ways.

[0023] The pump 5, or some other device for reducing the pressure in the vaporization chamber, and/or in the waste isolating container, will make it possible for the contents in the vaporization chamber, and/or the waste isolating container, to boil at temperatures below 100°C by creating a below-atmospheric pressure.

[0024] The water content in the waste isolating container can be reduced also without boiling. By simply adding heat energy to its liquid, vaporization will be enhanced by evaporation, even if there is no boiling.

[0025] In the first liquid-reduction step occurring in one or more reusable vaporization chamber(s), preferably 30% to 95% of the liquid is removed, more preferably 50-95 % of the liquid is removed, most preferably 70-95

% of the liquid is removed, and in the final liquid-reduction step that occurs in one or more waste isolating container(s), preferably another 10 % to 100%, more preferably 30% to 100% and most preferably 50% to 100% of the liquid in the waste isolating container is removed.

[0026] An additional way to increase the vaporization of water from the waste isolating container is to apply a below-atmospheric pressure in it for instance by use of a pump 5.

[0027] A further way to enhance the vaporization of water from the waste isolating container is to feed a gas into the waste isolating container via a gas inlet 6g, e.g. by bubbling a gas, such as air, into the liquid of the waste isolating container, either at atmospheric pressure or below atmospheric pressure.

[0028] As is described in Examples 1 and 2 below, this final reduction of water in the waste isolating container results in a very substantial reduction of produced waste material from the evaporator apparatus.

[0029] In the reusable vaporization chamber of the evaporation apparatus, it is advantageous to make sure that no liquid droplets, containing the potentially environmentally hazardous substances, will pass on to the evacuation unit 3 and the vapor condensing unit 4. This can be achieved by arranging a protective structure which is permeable to water vapor but which will capture any liquid droplets, as described in the co-pending PCT-application No. PCT/EP2016/075957.

Example 1

[0030] The method and apparatus according to the invention has been tested with some different types of liquids, viz.:

* Dulbecco's Modified Eagle's Medium with Penicillin 120 microgram and Streptomycin 100 microgram (Sigma-Aldrich).

* Dulbecco's Phosphate Buffered Saline with Penicillin 120 microgram and Streptomycin 100 microgram (Sigma-Aldrich).

* Human urine with Ciprofloxacine (Sigma-Aldrich) 10 mg/liter.

[0031] During vaporization in the reusable vaporization chamber 2a, it was found that removal of gradually more water resulted in more and more fouling of the walls. A reduction of more than 30 % of the water of the tested liquids, resulted in some soiling on the walls of the vaporization chamber. Removal of more than 50 % of the water, resulted in more pronounced fouling, removal of more than 70 % of the water, resulted in even more pronounced fouling and removal of more than 90 % of the water, resulted in an additional amount of even more pronounced fouling. Furthermore, removal of more than 90 % of the water led to an increased viscosity of the tested liquids, and when more than 95-97 % of the water had been removed, it was virtually impossible to transfer the waste from the vaporization chamber to the separate waste isolating container.

[0032] In order to further reduce the amount of waste material, additional water was removed in the waste isolating container. The removal in the waste isolating container of 10 % of the water in the liquid waste from the vaporization chamber resulted in some fouling on the walls and bottom of the waste isolating container. The removal in the waste isolating container of 40 % of the water in the liquid waste from the vaporization chamber resulted in large fouling on the walls and bottom of the waste isolating container. Even further removal of water transformed the liquid waste into a hard, non-liquid material. In general, it was possible to reduce the volume of the waste from the vaporization chamber by 80 % or even more by this final liquid-reducing step in the waste isolating container.

Example 2

[0033] 100 liters of urine containing the antibiotic Ciprofloxacine (10 mg/liters, Sigma Aldrich) was transferred to a reusable vaporization chamber and heated. When the volume had been reduced by about 90 % through vaporization, the remaining 10 liters of urine containing antibiotics were transferred to a waste isolating container. Here, all of the remaining water was removed by the use of heat, by applying a pressure lower than the ambient air pressure and by feeding a gas into the waste isolating container. As a result, the remaining urine turned into solid deposits on the walls and the bottom of the waste isolating container, and the volume of the waste was reduced by about 80 %.

Claims

1. A method to reduce the amount of waste, in a process involving vaporization in an evaporator apparatus (1-6, V1-V6), of a water solution containing environmentally hazardous substances, wherein

   - a considerable amount of the water content of said water solution is vaporized by heating in at least one reusable vaporization chamber (2a) in a first vaporization process;
   - the water content of said water solution being vaporized into vapor, which is released, possibly after condensation into water, to an ambient system;
   - the vaporization process is stopped at a certain time at which the remaining water solution is removed from said at least one reusable vaporization chamber for further processing;
   - said certain time is adjusted so that the water content in said at least one reusable vaporiza-

tion chamber (2a) is reduced, in said first vaporization process, by 30% to 95%, and the remaining water content is 70% to 5% of the initial water content, the remaining water content causing only minor deposits in said at least one vaporization chamber;
- said remaining water solution, at said certain time, is transferred from said at least one reusable vaporization chamber into at least one separate waste isolating container (6);
- whereupon said remaining water solution in said at least one waste isolating container is subjected to at least one further water-reducing process by heating, where the water content in said at least one waste container is further reduced by 10% to 100%;
- the combined water-reduction in said first and further water-reducing processes being such as to leave a final water content in said at least one waste container (6) of 10% to 0% of the initial water content of said water solution containing environmentally hazardous substances;
- the remaining waste in said at least one waste isolating container (6), including said environmentally hazardous substances, is left in said at least one waste isolating container for handling as waste;
- when the waste has reached a specified level in the at least one waste isolating container, the at least one waste isolating container is taken away and replaced; and
- the at least one waste container containing the waste is subjected to a destructive treatment, such as incineration.

2. The method according to claim 1, wherein, in said first vaporization process in said at least one reusable vaporization chamber (2a), the water content is reduced by 50% to 95%, so that the remaining water content is 50% to 5% of the initial water content.

3. The method according to claims 1 or 2, wherein, in said final water-reducing process in said at least one waste isolating container (6), the water content is further reduced by 30% to 100%, the combined water-reduction in said at least one reusable vaporization chamber (2a) and said at least one waste isolating container (6) being such as to leave a final water content in said at least one waste container (6) of 5 to 0% of the initial water content in said at least one reusable vaporization chamber (2a).

4. The method according to any one of the preceding claims, wherein, in said further water-reducing process in said at least one waste isolating container (6), the remaining water solution is heated.

5. The method according to any one of the preceding claims, wherein, in said further water-reducing process in said at least one waste isolating container (6), the remaining water solution is boiled.

6. The method according to any one of the previous claims, wherein, in said further water-reducing process in said at least one waste isolating container (6), vaporization is enhanced by applying a pressure lower than the ambient air pressure in said at least one waste isolating container.

7. The method according to any one of the previous claims, wherein, in said further water-reducing process in said at least one waste isolating container (6), vaporization is enhanced by feeding a gas into said at least one waste container.

8. The method according to any one of the preceding claims, wherein said water solution contains at least cells, a growth medium, and one or more of said environmentally hazardous substances such as antibiotics.

9. The method according to any one of the claims 1 to 7, wherein said water solution comprises urine with one or more dissolved antibiotics and/or one or more antibiotic residues.

10. An evaporator apparatus (1-6, V1-V6) for vaporization of a water solution containing environmentally hazardous substances and reducing the amount to be handled as waste, said apparatus comprising:

- a liquid receiving unit (1) for receiving said water solution;
- at least one reusable vaporization chamber (2a) for heating said water solution so as to vaporize water from said water solution for producing a remaining amount of the water solution;
- a vapor evacuation unit (3);
- a vapor releasing unit (4) which is connectable to an ambient system for releasing vapor or condensed water from the vaporization process,
- at least one waste isolating container (6), which is connected to said at least one reusable vaporization chamber (2a) for receiving said remaining amount of the water solution, and which is provided with a separate heating device (6a) arranged to subject the remaining amount of said water solution in said waste isolating container to at least one further heating and water reducing process, and to isolate a final remainder of said water solution therein as an even more concentrated material, including said environmentally hazardous substances and any possible deposits formed on the walls thereof, so that said waste isolating container with its isolated material can be handled as waste; and

- a level sensor (61) for determining when the waste in said at least one waste isolating container has reached a specified level at which time the at least one waste container is considered to be full and arranged to be replaced.

11. The evaporator apparatus according to claim 10, wherein said apparatus also comprises a pump (5) for reducing the pressure below the atmospheric pressure in said at least one reusable vaporization chamber (2a).

12. The evaporator apparatus according to claim 11, wherein said pump (5) for reducing the pressure below the atmospheric pressure is used also for said at least one waste isolating container (6).

13. The evaporator apparatus according to any of claims 10-12, wherein said at least one waste isolating container (6) is provided with a gas inlet (6g) for feeding gas into said at least one waste isolating container (6).

14. The evaporator apparatus according to any of claims 10-13, wherein a level sensor (21,61) is disposed in at least one of said at least one reusable vaporization chamber (2a) and said at least one waste isolating container (6).

Patentansprüche

1. Verfahren zur Verringerung der Abfallmenge, in einem Verfahren, das die Verdampfung in einer Verdampfungsvorrichtung (1 bis 6, V1 bis V6) einer Wasserlösung, die umweltschädliche Stoffe enthält umfasst, wobei

- eine beträchtliche Menge des Wassergehalts der Wasserlösung durch Erhitzen in mindestens einer wiederverwendbaren Verdampfungskammer (2a) in einem ersten Verdampfungsverfahren verdampft wird;
- der Wassergehalt der Wasserlösung, die zu Dampf verdampft wird, gegebenenfalls nach einer Kondensation zu Wasser in ein Umgebungssystem freigesetzt wird;
- das Verdampfungsverfahren zu einem bestimmten Zeitpunkt angehalten wird, zu dem die restliche Wasserlösung zur weiteren Verarbeitung aus der mindestens einen wiederverwendbaren Verdampfungskammer entfernt wird;
- der bestimmte Zeitpunkt angepasst wird, damit der Wassergehalt in der mindestens einen wiederverwendbaren Kammer (2a) in dem ersten Verdampfungsverfahren um 30 % bis 95 % verringert wird, und wobei der restliche Wassergehalt 70 % bis 5 % des anfänglichen Wassergehalts beträgt, wobei der restliche Wassergehalt nur kleine Ablagerungen in der mindestens einen Verdampfungskammer verursacht;
- die restliche Wasserlösung zu dem bestimmten Zeitpunkt von der mindestens einen wiederverwendbaren Verdampfungskammer in mindestens einen separaten Abfallisolationsbehälter (6) übertragen wird;
- woraufhin die restliche Wasserlösung in dem mindestens einen Abfallisolationsbehälter mindestens einem weiteren Wasserverringerungsverfahren durch Erhitzen unterzogen wird, wobei der Wassergehalt in dem mindestens einen Abfallbehälter weiter um 10 % bis 100 % verringert wird;
- die kombinierte Wasserverringerung in den ersten und zweiten Wasserverringerungsverfahren derart ist, dass ein endgültiger Wassergehalt von 10 % bis 0 % des anfänglichen Wassergehalts der Wasserlösung, die umweltschädliche Stoffe enthält in dem mindestens einen Abfallbehälter (6) zurückbleibt;
- der restliche Abfall in dem mindestens einen Abfallisolationsbehälter (6), einschließlich der umweltschädlichen Stoffe, zur Behandlung als Abfall in dem mindestens einen Abfallisolationsbehälter gelassen wird;
- wenn der Abfall in dem mindestens einen Abfallisolationsbehälter einen bestimmten Füllstand erreicht hat, der mindestens eine Abfallisolationsbehälter entfernt und ersetzt wird; und
- der mindestens eine Abfallbehälter, der den Abfall enthält, einer destruktiven Behandlung unterzogen wird, wie zum Beispiel Verbrennung.

2. Verfahren nach Anspruch 1, wobei der Wassergehalt in dem ersten Verdampfungsverfahren in der mindestens einen wiederverwendbaren Verdampfungskammer (2a) um 50 % bis 95 % verringert wird, sodass der restliche Wassergehalt 50 % bis 5 % des anfänglichen Wassergehalts beträgt.

3. Verfahren nach Anspruch 1 oder 2, wobei der Wassergehalt in dem letzten Wasserverringerungsverfahren in dem mindestens einen Abfallisolationsbehälter (6) weiter um 30 % bis 100 % verringert wird, wobei die kombinierte Wasserverringerung in der mindestens einen wiederverwendbaren Verdampfungskammer (2a) und in dem mindestens einen Abfallisolationsbehälter (6) derart ist, dass in dem mindestens einen Abfallbehälter (6) ein endgültiger Wassergehalt von 5 bis 0 % des anfänglichen Wassergehalts in der mindestens einen wiederverwendbaren Verdampfungskammer (2a) zurückbleibt.

4. Verfahren nach einem der vorhergehenden Ansprüche, wobei bei dem weiteren Wasserverringerungs-

verfahren in dem mindestens einen Abfallisolationsbehälter (6) die restliche Wasserlösung erhitzt wird.

5. Verfahren nach einem der vorhergehenden Ansprüche, wobei bei dem weiteren Wasserverringerungsverfahren in dem mindestens einen Abfallisolationsbehälter (6) die restliche Wasserlösung gekocht wird.

6. Verfahren nach einem der vorhergehenden Ansprüche, wobei in dem weiteren Wasserverringerungsverfahren in dem mindestens einen Abfallisolationsbehälter (6) die Verdampfung durch das Anwenden eines Drucks, der geringer als der Umgebungsluftdruck ist, in dem mindestens einen Abfallisolationsbehälter verbessert wird.

7. Verfahren nach einem der vorhergehenden Ansprüche, wobei in dem weiteren Wasserverringerungsverfahren in dem mindestens einen Abfallisolationsbehälter (6) die Verdampfung durch das Einführen eines Gases in den mindestens einen Abfallbehälter verbessert wird.

8. Verfahren nach einem der vorhergehenden Ansprüche, wobei die Wasserlösung mindestens Zellen, ein Nährmedium und einen oder mehrere umweltschädliche Stoffe, wie Antibiotika, enthält.

9. Verfahren nach einem der Ansprüche 1 bis 7, wobei die Wasserlösung Urin mit einem oder mehreren gelösten Antibiotika und/oder einem oder mehreren Antibiotikarückständen umfasst.

10. Verdampfungsvorrichtung (1 bis 6, V1 bis V6) zur Verdampfung einer Wasserlösung, die umweltschädliche Stoffe enthält, und zur Verringerung der Menge, die als Abfall behandelt werden muss, wobei die Vorrichtung Folgendes umfasst:

- eine flüssige Empfangseinheit (1) zum Erhalt der Wasserlösung;
- mindestens eine wiederverwendbare Verdampfungskammer (2a) zum Erhitzen der Wasserlösung, um das Wasser aus der Wasserlösung zu verdampfen, um eine Restmenge der Wasserlösung zu erzeugen;
- eine Dampfabführeinheit (3);
- eine Dampffreisetzungseinheit (4), die mit einem Umgebungssystem verbindbar ist, um den Dampf oder das kondensierte Wasser aus dem Verdampfungsverfahren freizusetzen;
- mindestens einen Abfallisolationsbehälter (6), der mit mindestens einer wiederverwendbaren Verdampfungskammer (2a) verbunden ist, um die restliche Menge der Wasserlösung zu erhalten, und der mit einer separaten Heizvorrichtung (6a) versehen ist, die angeordnet ist, um die Restmenge der Wasserlösung in dem Abfallisolationsbehälter mindestens einem weiteren Erhitzungs- und Wasserverringerungsverfahren zu unterziehen, und um einen endgültigen Rest der Wasserlösung darin als ein noch stärker konzentriertes Material zu isolieren, einschließlich der umweltschädlichen Stoffe und möglicher Ablagerungen, die an den Wänden davon gebildet sind, sodass der Abfallisolationsbehälter mit seinem isolierten Material als Abfall behandelt werden kann; und
- ein Füllstandsensor (6l), um zu bestimmen, wann der Abfall in dem mindestens einen Abfallisolationsbehälter einen bestimmten Füllstand erreicht hat, bei dem der mindestens eine Abfallbehälter als voll erachtet und zum Austausch vorgesehen wird.

11. Verdampfungsvorrichtung nach Anspruch 10, wobei die Vorrichtung auch eine Pumpe (5) zur Verringerung des Drucks unter den Umgebungsdruck in der mindestens einen wiederverwendbaren Verdampfungskammer (2a) umfasst.

12. Verdampfungsvorrichtung nach Anspruch 11, wobei die Pumpe (5) zur Verringerung des Drucks unter den Umgebungsdruck auch für den mindestens einen Abfallisolationsbehälter (6) verwendet wird.

13. Verdampfungsvorrichtung nach einem der Ansprüche 10 bis 12, wobei der mindestens eine Abfallisolationsbehälter (6) mit einem Gaseinlass (6g) zum Einführen von Gas in den mindestens einen Abfallisolationsbehälter (6) versehen ist.

14. Verdampfungsvorrichtung nach einem der Ansprüche 10 bis 13, wobei ein Füllstandsensor (21, 61) in mindestens einer der mindestens einen wiederverwendbaren Verdampfungskammer (2a) und in dem mindestens einen Abfallisolationsbehälter (6) angeordnet ist.

Revendications

1. Procédé de réduction de la quantité de déchets, dans un processus impliquant la vaporisation dans un appareil évaporateur (1-6, V1-V6), d'une solution aqueuse contenant des substances dangereuses pour l'environnement, dans lequel

- une quantité considérable de la teneur en eau de ladite solution aqueuse est vaporisée par chauffage dans au moins une chambre de vaporisation réutilisable (2a) dans un premier processus de vaporisation ;
- la teneur en eau de ladite solution aqueuse étant vaporisée en vapeur, qui est dégagée,

éventuellement après la condensation dans l'eau, dans un système ambiant ;
- le processus de vaporisation est arrêté à un certain moment auquel la solution aqueuse résiduelle est retirée de ladite au moins une chambre de vaporisation réutilisable pour un traitement supplémentaire ;
- ledit certain moment est ajusté de manière à ce que la teneur en eau dans ladite au moins une chambre de vaporisation réutilisable (2a) soit réduite, dans ledit premier processus de vaporisation, de 30 % à 95 %, et la teneur en eau résiduelle est de 70 % à 5 % de la teneur en eau initiale, la teneur en eau résiduelle n'entraînant que des dépôts mineurs dans ladite au moins une chambre de vaporisation ;
- ladite solution aqueuse résiduelle, au dit certain moment, est transférée depuis ladite au moins une chambre de vaporisation réutilisable dans au moins un récipient d'isolement de déchets séparé (6) ;
- après quoi ladite solution aqueuse résiduelle dans ledit au moins un récipient d'isolement de déchets est soumise à au moins un autre processus de réduction de déchets par chauffage, dans lequel la teneur en eau dans ledit au moins un récipient de déchets est en outre réduite de 10 % à 100 % ;
- la réduction d'eau combinée dans lesdits premier et autre processus de réduction d'eau étant telle qu'elle laisse une teneur en eau finale dans ledit au moins un récipient de déchets (6) de 10 % à 0 % de la teneur en eau initiale de ladite solution aqueuse contenant les substances dangereuses pour l'environnement ;
- les déchets résiduels dans ledit au moins un récipient d'isolement de déchets (6), incluant lesdites substances dangereuses pour l'environnement, sont laissés dans ledit au moins un récipient d'isolement de déchets pour être manipulés comme des déchets ;
- lorsque les déchets ont atteint un niveau spécifié dans l'au moins un récipient d'isolement, l'au moins un récipient d'isolement de déchets est retiré et remplacé ; et
- l'au moins un récipient de déchets contenant les déchets est soumis à un traitement de destruction, tel que l'incinération.

2. Procédé selon la revendication 1, dans lequel, dans ledit premier processus de vaporisation dans ladite au moins une chambre de vaporisation réutilisable (2a), la teneur en eau est de réduite de 50 % à 95 %, de manière à ce que la teneur eau résiduelle soit de 50 % à 5 % de la teneur en eau initiale.

3. Procédé selon la revendication 1 ou 2, dans lequel, dans ledit processus de réduction d'eau final dans ledit au moins un récipient d'isolement de déchets (6), la teneur en eau est en outre de réduite de 30 % à 100 %, la réduction d'eau combinée dans ladite au moins une chambre de vaporisation réutilisable (2a) et ledit au moins un récipient d'isolement de déchets (6) étant telle qu'elle laisse une teneur en eau finale dans ledit au moins un récipient de déchets (6) de 5 à 0 % de la teneur en eau initiale dans ladite au moins une chambre de vaporisation réutilisable (2a).

4. Procédé selon l'une quelconque des revendications précédentes, dans lequel, dans ledit autre processus de réduction d'eau dans ledit au moins un récipient d'isolement de déchets (6), la solution aqueuse résiduelle est chauffée.

5. Procédé selon l'une quelconque des revendications précédentes, dans lequel, dans ledit autre processus de réduction d'eau dans ledit au moins un récipient d'isolement de déchets (6), la solution aqueuse résiduelle est portée à ébullition.

6. Procédé selon l'une quelconque des revendications précédentes, dans lequel, dans ledit autre processus de réduction d'eau dans ledit au moins un récipient d'isolement de déchets (6), la vaporisation est améliorée par application d'une pression inférieure à la pression de l'air ambiant dans ledit au moins un récipient d'isolement de déchets.

7. Procédé selon l'une quelconque des revendications précédentes, dans lequel, dans ledit autre processus de réduction d'eau dans ledit au moins un récipient d'isolement de déchets (6), la vaporisation est améliorée par alimentation d'un gaz dans ledit au moins un récipient de déchets.

8. Procédé selon l'une quelconque des revendications précédentes, dans lequel ladite solution aqueuse contient au moins des cellules, un milieu de croissance, et une ou plusieurs substances dangereuses pour l'environnement telles que des antibiotiques.

9. Procédé selon l'une quelconque des revendications 1 à 7, dans lequel ladite solution aqueuse comprend de l'urine avec un ou plusieurs antibiotiques dissous et/ou un ou plusieurs résidus d'antibiotiques.

10. Appareil évaporateur (1-6, V1-V6) pour la vaporisation d'une solution aqueuse contenant des substances dangereuses pour l'environnement et la réduction de la quantité à manipuler sous la forme de déchets, ledit appareil comprenant :

- une unité de réception de liquide (1) pour recevoir ladite solution aqueuse ;
- au moins une chambre de vaporisation réutili-

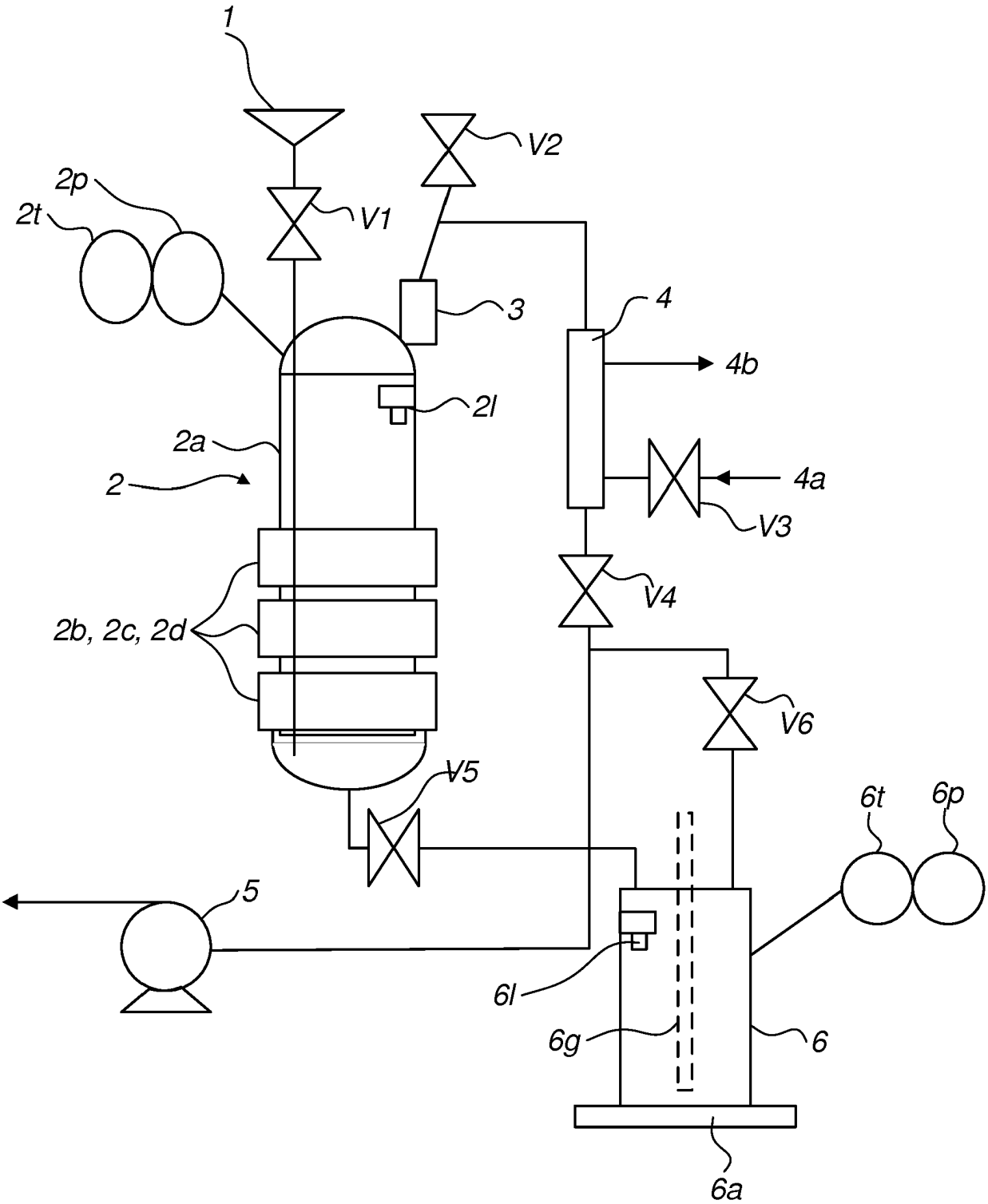
sable (2a) pour chauffer ladite solution aqueuse de manière à vaporiser l'eau de ladite solution aqueuse pour produire une quantité résiduelle de la solution aqueuse ;
- une unité d'évacuation de vapeur (3) ;
- une unité de dégagement de vapeur (4) qui peut être raccordée à un système ambiant pour relâcher la vapeur ou l'eau condensée du processus de vaporisation,
- au moins un récipient d'isolement de déchets (6), qui est raccordé à ladite au moins une chambre de vaporisation réutilisable (2a) pour recevoir ladite quantité résiduelle de la solution aqueuse, et qui est doté d'un dispositif de chauffage distinct (6a) agencé pour soumettre la quantité résiduelle de ladite solution aqueuse dans ledit récipient d'isolement de déchets à au moins un autre processus de chauffage et de réduction d'eau, et pour isoler un reste final de ladite solution aqueuse à l'intérieur de celui-ci sous la forme d'un matériau encore plus concentré, incluant lesdites substances dangereuses pour l'environnement et tout dépôt éventuel formé sur ses parois, de manière à ce que ledit récipient d'isolement de déchets avec son matériau isolé puisse être manipulé comme des déchets ; et
- un capteur de niveau (6l) pour déterminer le moment où les déchets dans ledit au moins un récipient d'isolement de déchets atteignent un niveau spécifié, moment auquel l'au moins un récipient de déchets est considéré plein et est agencé pour être remplacé.

11. Appareil évaporateur selon la revendication 10, dans lequel ledit appareil comprend également une pompe (5) pour réduire la pression au-dessous de la pression atmosphérique dans ladite au moins une chambre de vaporisation réutilisable (2a).

12. Appareil évaporateur selon la revendication 11, dans lequel ladite pompe (5) de réduction de la pression au-dessous de la pression atmosphérique est également utilisée pour ledit au moins un récipient d'isolement de déchets (6).

13. Appareil évaporateur selon l'une quelconque des revendications 10 à 12, dans lequel ledit au moins un récipient d'isolement de déchets (6) est doté d'une entrée de gaz (6g) pour alimenter en gaz ledit au moins un récipient d'isolement de déchets (6).

14. Appareil évaporateur selon l'une quelconque des revendications 10 à 13, dans lequel un capteur de niveau (21, 61) est disposé dans au moins l'un de ladite au moins une chambre de vaporisation réutilisable (2a) et dudit au moins un récipient d'isolement de déchets (6).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REFERENCES CITED IN THE DESCRIPTION

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