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ABSTRACT

The invention concerns a device for isolation of material, such as medical substances, present in dissolved state in human or animal urine. Said device comprises a urine receiving unit (3), a vaporization chamber (6) being in fluid communication with said urine receiving unit, a vapor evacuation unit being in fluid/vapor communication with said vaporization chamber, means for regulating pressure in the vaporization chamber, means for heating the vaporization chamber, and a waste container (9) for receiving waste from the vaporization chamber. The waste container is in fluid communication with the vaporization chamber. The invention further regards a method for isolation of material, such as medical substances, present in dissolved state in human or animal urine.

To be published with Fig. 1

DEVICE AND A METHOD FOR ISOLATION OF MATERIAL PRESENT IN HUMAN OR ANIMAL URINE

TECHNICAL FIELD

On a general level, the disclosure relates to a device and a method for isolation of material, such as medical substances, present in dissolved state in human or animal urine.

BACKGROUND

Medical substances such as antibiotics, cytostatics and non-steroid, anti-inflammatory drugs are widely used to treat sick persons, and are sometimes also used to treat animals. Furthermore, it is commonplace in many countries to administer antibiotics to healthy animals, for the purpose of making them grow faster. Any administered substances are absorbed into the body of the individual. Here, they circulate for some time and are subsequently excreted in original or metabolized form, mainly via the urine. The excreted urine eventually enters the wastewater system. Because wastewater treatment plants typically do not have the capacity to remove medical substances from the incoming wastewater, considerable amounts of medical substances end up in the environment.

In a recent scientific article, entitled “Selective Pressure of Antibiotic Pollution on Bacteria of Importance to Public Health”, authored by A.Tello, B. Austin and T. Telfer and published in 2012 on pages 1100–1106 of Environmental Health Perspectives (Volume 120), it has been shown that even very low concentrations of antibiotics in the environment can lead to an increased prevalence of antibiotic resistant bacteria. Furthermore, it is also quite possible that development of antibiotic resistance occurs already in the waste water system. In particular, the pipes of the waste water system contain enormous numbers of bacteria. When exposed to antibiotics for a long time, they can become increasingly resistant to the antibiotics.

Many patients in hospitals are severely ill and are therefore often treated with broad-spectrum antibiotics. It would be extremely unfortunate if bacteria developed resistance to these especially valuable antibiotics so that they became useless.

In the related context, in a European Union Fact sheet (http://ec.europa.eu/research/fp7/pdf/antimicrobial_resistance_fact_sheet.pdf) it is disclosed that more than 25 000 people in the EU die each year from infections caused by drug resistant bacteria, including multiresistant bacteria, and that antibiotic-resistant germs are regularly found in many hospitals throughout the EU, infecting 4 million patients every year.

US3506543 discloses a device and a method of providing potable water from human urine under the conditions found in space travel. US20120055777 deals with reuse of the fluid fraction of the urine as a flushing liquid for restroom fixtures. However, none of these disclosures address the specific challenges that the removing of medical substances from urine presents. In particular, the disclosed devices are structurally unfit to ensure a quality-controlled, effective removal of medical substances from the urine in conjunction with an economic handling of the waste.

WO2014/011111 proposes to employ activated carbon in order to solve the problem of release of potentially harmful substances into the wastewater system. However, the use of activated carbon for this purpose is ridden with considerable drawbacks. In particular and as is known in the art, activated carbon is a lipophilic material with a poor ability to bind to hydrophilic medical substances dissolved in urine. Accordingly, large amounts of activated carbon are required if substantial amounts of urine are to be handled, which requires frequent changes of the active charcoal filter. A further problem is created hereby as these large amounts of activated carbon need to be disposed in a safe and environmentally friendly manner. Moreover, structural properties of the used device, inter alia the presence of a process reactor comprising an activated carbon bed, create a considerable

risk of multi resistant bacteria developing in the reactor due to the prolonged contact between bacteria originating from the urine and antibiotics. In order to avoid this, very frequent replacement of the carbon bed is required. Obviously, this complicates and prolongs the process and reduces the usefulness of the proposed solution.

In addition to the above discussed ways of dealing with the problem of antibiotics being released into the environment, and thus contributing to creation of multi-resistant bacteria, further methods are known in the art. By way of example, urine samples containing antibiotics could be UV-treated in order to incapacitate antibiotics. In order to disable antibiotics, further methods of radiation- and/or ozone treatment could be employed. The samples could also undergo a chemical treatment, such as hydrolysis or oxidation, having the same purpose. However, each of these methods is associated with considerable problems if used for the purpose discussed in this application.

On the above background, it is an object of the present invention to provide a device and a method that alleviate at least some of the drawbacks associated with the current art. In particular, main objectives of the present invention are to enable a quality controlled, effective and economic isolation of dissolved substances in the urine.

SUMMARY OF THE INVENTION

The above stated objective is achieved by means of the device and the method according to the independent claims, and by the embodiments according to the dependent claims.

A general object of the disclosure is to isolate unwanted substances that are dissolved in urine by removal of substantial amounts of water from the urine. The water is released to the public sewage system. The remaining waste (unwanted substances plus urine solutes such as urea plus as little water as possible) may subsequently be incinerated in a high temperature oven or like.

An effective and economical process requires:

- removal of as much water from the urine as possible, water being subsequently released to the public sewage system,
- presence of as little pollution in the water that reaches the sewage system as possible, and
- production of as little waste as possible.

The device has several important features which were found to be necessary in order to get a quality controlled, effective isolation of unwanted substances, and an economic handling of waste.

In one aspect, the present disclosure relates to a device suitable for isolation of material, in particular medical substances, present in dissolved state in human or animal urine. The device comprises a urine receiving unit suitable for receiving urine and a vaporization chamber being in fluid communication with the urine receiving unit. The device further comprises a vapor evacuation unit suitable for receiving vapor from the vaporization chamber and wherein the vapor evacuation unit comprises a protective structure arranged in fluid communication with the vaporization chamber. The protective structure feature permeability to vapor while passage of mist-building droplets (aerosols) is prevented. In fluid communication with the protective structure there is arranged a condensation unit suitable for receiving vapor from the vapor evacuation unit via the protective structure.

In another aspect of the disclosure, the invention concerns a device suitable for isolation of material, in particular medical substances, present in dissolved state in human or animal urine, said device. The device comprises a urine receiving unit, a vaporization chamber being in fluid communication with said urine receiving unit, and a vapor evacuation unit suitable for receiving vapor from said vaporization chamber. The device comprises a condensation unit suitable for receiving vapor from said vapor evacuation unit via said protective structure, means for heating the vaporization chamber, a dosing unit for adding of a non-corrosive anti-foaming agent to said vaporization chamber, a waste container for

receiving waste generated in the vaporization chamber through vaporization of urine. The container being in fluid communication with said vaporization chamber. The inventive device further comprising the vapor evacuation unit, which in turn comprises a protective structure arranged in fluid communication with said vaporization chamber. The protective structure is vapor permeable and prevents passage of mist-building droplets (aerosols) from the vaporization chamber.

The device may further comprise at least one heater adapted to heat the protective structure for preventing vapor from condensing at the protective structure.

The device further comprises means, such as a pump, which reduces pressure in the vaporization chamber such that a below atmospheric pressure is achieved. This gives a better control of the vaporization process in relation to the boiling point of the human or animal urine. This also reduces bad smell emanating out of the vaporization chamber.

The device may further comprise means for heating the vaporization chamber at least such that the content of the vaporization chamber may boil at the below atmospheric pressure created by the means for reducing pressure. The boiling may be done at a first temperature being sufficient to vaporize said urine and to destroy all living microorganisms present in said urine, The boiling may be done at a first temperature being sufficient to vaporize said urine and the urine may be exposed to a second temperature sufficient to destroy all living microorganisms present in said urine.

The device may further comprise a dosing unit for adding of a non-corrosive anti-foaming agent to the vaporization chamber in order to prevent foaming and/or corrosion during operation.

The device may further comprise a waste container for receiving waste generated in the vaporization chamber through vaporization of urine, the container being in fluid communication with the vaporization chamber.

The device may further comprise a urease dosing unit. The urease dosing unit may inject a dosage of urease at any step of the process. A dosage may be pre calculated or it may be adjusted based on measurements carried out in the process. The urease dosing unit may inject a dosage of urease at any step of the process. A dosage may be pre-calculated or it may be adjusted based on measurements carried out in the process.

In one embodiment of the disclosure, the urease dosing unit is arranged externally of the device suitable for isolation of material. This reduces the amount and generation of waste considerably prolonging both the operation time of the device and use of the waste container before the waste container must be replaced by a new empty one. This also improves the economy of the device.

The device may further comprise an analytical unit arranged at any stage, either upstream or downstream of the protective structure. The analytical unit may be adapted to determine the amount of impurities in a condensate derived from the condensation unit and/or it may be adapted to determine the amount of impurities in the received urine or in the vaporization chamber.

In one embodiment, the analytical unit may determine the amount of impurities by measuring conductivity. In a further embodiment, the analytical unit may determine the amount of impurities by measuring absorbance. In yet a further embodiment, the analytical unit may determine the amount of impurities by measuring conductivity and absorbance.

In a yet further embodiment, the device may comprise a microorganism reduction unit arranged so as to be in fluid communication with the urine receiving unit and

with the vaporization chamber. The microorganism reduction unit may be arranged to heat up the received urine to a temperature exceeding 60 ^{0}C.

In one embodiment, the non-corrosive anti-foaming agent may comprise at least one of paraffins, fatty acids and tensids.

In one embodiment, the waste container may be releasable attached, sealable and exchangeable.

In one embodiment, the protective structure may comprise a maze structure, a plurality of porous deformable filling bodies or at least one polymer sponge.

In one embodiment, the protective structure may comprise a demister. In another embodiment, the protective structure is a demister. In yet another embodiment, the protective structure may comprise more than one demister. A first possible solution is having more than one protective structure comprising one or more demisters each according to the invention. Another possible solution according to the invention is having more than one protective structure, wherein at least one protective structure comprises one demister and at least one protective structure comprises more than one demister according to the invention.

One possible solution according to the invention is having more than one protective structure, wherein at least one protective structure is coupled in series with at least one other protective structure in the fluid communication with the vaporization chamber according to the invention. Another possible solution according to the invention is having more than one protective structure, wherein at least one protective structure is coupled in parallel with at least one other protective structure in the fluid communication with the vaporization chamber according to the invention.

Yet another possible solution according to the invention is having more than one protective structure, wherein at least one protective structure is coupled in parallel

with at least one other protective structure and at least one protective structure is coupled in series with at least one other protective structure in the fluid communication with the vaporization chamber and according to the invention.

At least one demister may be arranged, i.e. coupled, in parallel or in series with at least one other demister in one or more protective structures according to the invention. One or more demisters may be arranged, i.e. coupled, in parallel and in series with at least one or more other demisters in one or more protective structures according to the invention.

Another possible solution is having more than one protective structure comprising at least two demisters being coupled in parallel with each other according to the invention. Yet another possible solution is having more than one protective structure comprising at least two demisters being coupled in series with each other according to the invention. Still another possible solution is having more than one protective structure, wherein each protective structure comprises a combination of at least one demister being coupled in series with at least one other demister and at least one demister being coupled in parallel with at least one other demister according to the invention.

In one embodiment, the device may be dimensioned and assembled as a unit suitable for mobility within an indoor environment such as a hospital. This makes the device according to the invention compact and easy to handle and transport indoor. The device according to the invention is also downscaled in weight, not only in size/dimensions, so that any transportation and lifting of it is facilitated. This is especially advantageous when moving it between floors by elevator and between rooms on the same floor and over doorsteps, which portability is of great importance at hospitals to make the use of the inventive device much more flexible. This downsized device according to the invention also reduces costs as the number of devices to buy may be held to minimum as one device is easily moved to another location indoor, e.g. between nursing wards in a hospital or in nursing homes or in eldercares or in welfare centers. This device has the same

advantages if utilized in animal breeding facilities and/or in dairy farming when processing animal urine.

In a further aspect of the disclosure, the invention relates to a method for isolation of material, in particular medical substances, present in dissolved state in human or animal urine. The method may comprise one or more of the following steps:

- receiving urine,
- transferring the received urine into a vaporization chamber,
- exposing the urine present in the vaporization chamber to a first below atmospheric pressure and simultaneously therewith exposing the urine to a first temperature sufficient to destroy all living microorganisms present in said urine,
- adding a non-corrosive antifoaming agent to said vaporization chamber in order to reduce foaming.
- evacuating the vapor generated in the vaporization chamber,
- leading the evacuated vapor through a protective structure which hinders liquid but allows vapor to pass through,
- condensing vapor downstream of said protective structure and
- conveying waste generated in the vaporization chamber through vaporization of urine to a waste container, once said waste meets a predetermined criteria or after a predetermined time period.

In still a further aspect of the disclosure, the invention relates to a method for isolation of material, in particular medical substances, present in dissolved state in human or animal urine, wherein said method comprises following steps:

- receiving urine,
- transferring the received urine into a vaporization chamber,
- exposing the urine present in the vaporization chamber to a first below atmospheric pressure, and simultaneously therewith exposing the urine to temperatures sufficient to vaporize said urine and to destroy all living microorganisms present in said urine,

- adding a non-corrosive antifoaming agent to said vaporization chamber in order to reduce foaming,
- evacuating the vapor generated in the vaporization chamber,
- leading the evacuated vapor through a protective structure which hinders liquid but allows vapor to pass through,
- condensing vapor downstream of said protective structure,
- conveying waste generated in the vaporization chamber through vaporization of urine to a waste container, once said waste meets a predetermined criteria or after a predetermined time period, and
- heating the protective structure to prevent vapor from condensing at the protective structure.

In one embodiment, the method may further comprise exposing the urine present in the vaporization chamber to a first below atmospheric pressure and simultaneously therewith exposing the urine to a temperatures sufficient to vaporize the urine by boiling and destroy all living microorganisms present in said urine, e.g. a first temperature sufficient to vaporize the urine by boiling and a second temperature sufficient to destroy all living microorganisms present in said urine.

In one embodiment, the method may further comprise reducing the amount of urea in the urine held in the vaporization chamber by exposing said urine to urease. In one embodiment, the step of reducing the amount of urea in the urine held in the vaporization chamber by exposing said urine to urease is performed by means of arranging an urease dosing unit externally of the device.

In a further embodiment, the method may further comprise condensing the vapor downstream of the protective structure so that the amount of impurities in the evacuated vapor is determined using a condensate of the vapor that passed through the protective structure.

In a yet further embodiment, the step of determining the amount of impurities in the evacuated vapor may comprise measuring conductivity or absorbance.

In a further embodiment, the method may further comprise heating up the received urine to a temperature exceeding 60 ^{0}C prior to transferring it further.

In a further aspect of the disclosure, the invention relates to a device suitable for isolation of material, in particular medical substances, present in dissolved state in human or animal urine. The device comprising:

- a urine receiving unit,
- a vaporization chamber being in fluid communication with the urine receiving unit,
- a vapor evacuation unit suitable for receiving vapor from the vaporization chamber,
- means, such as a pump, for regulating pressure in the vaporization,
- means for heating the vaporization chamber,
- a dosing unit for adding of a non-corrosive anti-foaming agent to the vaporization chamber and
- a waste container for receiving waste generated in the vaporization chamber through vaporization of urine, the container being in fluid communication with the vaporization chamber.

In still a further aspect of the disclosure, the invention relates to a device suitable for isolation of material, such as medical substances, present in dissolved state in human or animal urine, said device comprising:

- a urine receiving unit,
- a vaporization chamber being in fluid communication with said urine receiving unit,
- a vapor evacuation unit suitable for receiving vapor from said vaporization chamber,
- means, such as a pump, for regulating pressure in the vaporization chamber and aiding in conveyance of fluid,

- means for heating the vaporization chamber,
- a dosing unit for adding of a non-corrosive anti-foaming agent to said vaporization chamber and
- a waste container for receiving waste generated in the vaporization chamber through vaporization of urine, the waste container being in fluid communication with said vaporization chamber.

In still another embodiment, the device comprises and the method uses at least one heater for heating the protective structure to prevent vapor from condensing at the protective structure. In a further embodiment, the heater is arranged externally of the device suitable for isolation of material. In yet a further embodiment of the device, the heater is arranged externally of the protective structure or integrated in the protective structure.

In an additional embodiment of the device, the protective structure is at least one demister or comprises at least one demister.

It is to be noted that, where applicable, the method steps do not have to take place in the above order. Moreover, the term vaporization is here to be construed as a phase transition from the liquid phase to gas phase either through evaporation or through boiling.

The beneficial effects of using below atmospheric pressure are the reduction of the smelling of urine during evaporation and a reduced fouling on the walls of the vaporization chamber due to the reduction of the boiling point of urine.

Protective structure

During conducted tests, a protective structure has proven to be a vital feature in effective removal of dissolved substances from the urine. As is described in Example 1, it was found that when the present machine was operated with a protective structure, the ability to isolate the antibiotic ciprofloxacine was 50 times more effective compared to when a protective structure was not utilized. Furthermore, it was found that a simple splash protection in the form of a metal plate in

front of the vapor outlet was not sufficient. Instead, a protective structure with the ability to stop small water droplets in the form of aerosol was necessary to achieve an effective isolation of the dissolved substance.

A suitable protective structure comprises at least one demister, i.e. a unit made of thin threads of metal arranged at fixed distances and working as a grid/net/lattice for effectively preventing aerosol/droplets to pass through and enabling only for vapor to pass through the protective structure by enabling only single/separate/individual/solitary molecules of vapor to pass through.

The device and method according to the invention may utilize at least one protective structure to achieve an effective prevention of dissolved undesired substances, in particular medical ones, passing through the device.

The device and method according to the invention may utilize at least two protective structures, either coupled in series and/or in parallel, to improve the prevention of dissolved undesired substances, in particular medical ones, passing through the device.

The device and method according to the invention may utilize at least two protective structures comprising at least one demister each to achieve an effective prevention of dissolved undesired substances, in particular medical ones, passing through the device.

The device and method according to the invention may utilize at least two protective structures comprising at least two demisters each to improve the prevention of dissolved undesired substances, in particular medical ones, passing through the device.

The device and method according to the invention may utilize at least one protective structure being arranged in parallel with at least one other protective structure and/or at least one protective structure being arranged in series with at

least one other protective structure, wherein each protective structure comprises at least one demister to achieve an effective prevention of dissolved undesired substances, in particular medical ones, passing through the device.

The inventors have performed tests with and without any protective structure, e.g. any demister. The tests showed unexpectantly that at least one protective structure, e.g. at least one demister, in the device according to one aspect of the invention, is effective in preventing aerosols/droplets to pass through but reduces the vaporization rate in the device. A device for testing of this aspect of the invention vaporized 1.3 litres of fluid/hour without a protective structure and only 0.5 litres of fluid/hour with a protective structure. The reason for this is that vapor and aerosol condense in the protective structure and flows back to the vaporization chamber of the device.

However, the inventors have surprisingly discovered that another aspect of the inventive device maintain or even improve the prevention of aerosols/droplets from passing through the protective structure but also increases the vaporization rate of the device at the same time. This aspect concerns heating a protective structure, e.g. a demister, so that the above condensing is eliminated or at least reduced in the protective structure, whereby the vaporization rate of the device then is about or at least 1.1 litres of fluid/hour.

The heating of at least one protective structure and/or at least one demister are/is achieved by arranging a heating element on the protective structure or the demister to heat it by being thermally connected therewith. The heating could also be achieved by arranging a heating element or heater externally of the protective structure and/or the demister to heat either the protective structure or the demister or both entities, e.g. electrically. The heating is possible to achieve by electrical means and/or heat exchanging.

Urease unit to reduce waste production

Urine contains 37.1 g solutes/liter and of that 13.4 g is urea (Puttman DF, Composition and concentrative properties of human urine, NASA July, 1971). In

order to reduce the amount of waste, urease was used. A urease dosing unit may be present either upstream of the vaporization chamber, in the vaporization chamber or in the waste container. Urease converts urea to ammonium ions and carbon dioxide that is in gaseous state. In this way, the amount of solid-state waste material may be further reduced by up to about 30 %.

By use of urease, waste is reduced in any device according to the invention, also in devices not having a protective structure according to the invention. For some devices according to the invention, there may be no need for any protective structure as the added urease by itself reduces generated waste amounts. However, a protective structure is very advantageous in the smaller sized device according to the invention. Alternatively, as a further improvement of the device according to the invention, a protective structure combined with addition of urease reduces the amount of generated waste even further. This also aids in making a cleaner condensate. Less waste reduces the cost for incineration of waste and also for service/maintenance personnel due to need of fewer people handling this and due to a decreased cost for each waste container being recyclable and re-usable.

The inventors have performed tests to clarify that if addition of external urease is used, this usage is able to reduce the production of waste material from the machine/device to a great extent. In tests, 10 liters of urine were collected and fed to the evaporator. After all the water had been vaporized, this resulted in an amount of 3 dl waste. After cleaning of the device, another 10 liters of urine was added. However, before this urine was added to the device, this urine had been treated with 100KU Urease (100 000 units/gram solids) from Canavalia ensiformis for 30 minutes. Then, after evaporation of all the water in the urine, 2 dl waste remained. Thus, treatment with external urease reduced the waste production by about 30 % compared to for example spontaneously generated urease producing bacteria that can simply not reduce the amount of waste to the extent and with the repeatability as achieved by the inventive device and method, especially not in humans.

Analytical unit to evaluate the purity of the vapor and provide quality control of the process

In order to make sure that the vapor from the vaporization chamber is sufficiently clean, an analytical unit to evaluate the purity was used. This was done either through measuring conductivity of condensed vapor or by determining its absorbance. The calculated data may be registered, stored and/or presented to the device operator via the control panel. The device may have online monitoring of the quality of the isolation process. This continuous quality control ensures that the condensed vapor from the device is sufficiently pure to be released in the public sewage system.

Microorganism sterilization unit/auxiliary heating unit

Urine may contain harmful microorganisms such as bacteria and viruses. This may result in a health hazard to humans that for instance are changing waste container. It is possible that the heating in the vaporization chamber is not sufficient to kill hardy microorganisms such as tuberculosis in spore form. In order to kill all microorganisms, a separate auxiliary heating unit may be employed. In this application, the terms auxiliary heating unit and microorganism sterilization unit are interchangeably used. Said unit heats the urine to at least 60° C for a sufficient time period in order to kill the microorganisms. It may also add anti-bacterial chemicals such as hydrogen peroxide for this purpose.

Non-corrosive antifoaming agent unit

When urine boils it results in the generation of significant amounts of foam, which may negatively affect the normal function of this device. US3506543 disclose the use of 3 % sulphuric acid to reduce foaming. However, this acid may corrode the stainless steel of the device and reduce its useful life. Therefore, a non-corrosive, antifoaming agent based on paraffins, fatty acids and tensids was used (hebro®d-foam 2060).

Further advantages and features of embodiments will become apparent in the following detailed description in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a device for use in a care institution and according to an embodiment of the present invention.

Fig. 2a is a schematic, cross-sectional view showing the protective structure being part of a device according to one embodiment of the present invention.

Fig. 2b is a schematic, cross-sectional view showing the protective structure being part of a device according to another embodiment of the present invention.

Fig. 3 is a schematical visualisation of a process performed by a device according to an embodiment of the present invention.

Figs. 4A and 4B show flow charts of methods for isolation of material, in particular medical substances, present in dissolved state in human or animal urine according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a perspective view of a device 1 for use in a care institution, such as an intensive care unit or a unit for treatment of infectious diseases, and according to an embodiment of the present invention. More specifically, different parts of the device 1 are shown. In this context, it is to be noted that pipes that in this embodiment would ensure fluid communication between different parts of the device have been left out from Fig. 1. Said parts are mounted on a base structure 2 comprising a first section 2a extending in a substantially horizontal plane and a second section 2b extending in a substantially vertical plane. The first section 2a has a first face that faces parts of the device, and a thereto opposite second face. Analogously, the second section 2b has a first face that faces parts of the device and a thereto opposite, second face.

Four peripherally positioned casters 4 are attached to the first section. The casters make the device 1 easily movable. A control cabinet 16 and a thereto associated control panel 17 are affixed to the second section 2b, more particularly to its second face. These components will be discussed in detail further below.

A funnel-shaped urine receiving unit 3, typically made in stainless steel, is via an arm attached to the second section 2b. In this context, the urine receiving unit 3 may be embodied in different ways e.g. as a cylinder, a parallelepiped or a pipe. The unit may further comprise a hinged lid 11 that prevents inadvertent ejection of the urine e.g. due to sudden movements of the device. Urine is typically manually fed into the unit from a potty, a catheter bag or similar device. Urine from the receiving unit is transferred to the vaporization chamber 6. The vaporization chamber is typically made in stainless steel but may also be made from other material such as plastic or carbon fiber. In the same context, its top surface 14 is provided with a plurality of pipe connections. Its bottom surface is also provided with a pipe connection. For use in hospital environment the capacity of the chamber 6 is usually approximately 10 liters, but other values are conceivable. The chamber 6 is provided with at least one sensor for measuring process properties.

In a variant, the vaporization chamber 6 is also provided with stirring means (not shown) that in an exemplary embodiment are embodied as a centrally journalled arm rotating in a horizontal plane. In some embodiments the stirring is achieved by means of magnetic forces.

The vaporization chamber 6 may be heated in different ways. In one embodiment, its walls are heated and the heat is subsequently conductively transferred to the urine in the chamber. In an alternative embodiment, a dedicated heating element may be at least partially immersed in the urine contained in the chamber. It is also envisaged to supply heat to the chamber via a medium such as water or steam. The vaporization chamber is, during operation, kept at below atmospheric pressure. This is achieved by use of a pump 15. The pump also assists the

transferring of urine between different receptacles of the device by creating pressure differences. In one embodiment, the pump 15 is a liquid ring pump. The choice of this type of pump entails that the vapor from the vaporization chamber 6 may condense in the pump itself. As an alternative, a diaphragm pump or any other type of pump may be used. The pump is typically powered by a motor. A waste container 9 for receiving isolated material from the vaporization chamber 6 is releasably attached to the first section 2a of the base structure 2. It may be immobilized relative the base structure 2 by means of straps or similar locking means. The container is advantageously made in a suitable polymer material.

A control cabinet 16, shown in Fig. 1, comprises a control unit. The control unit typically has a memory unit (not shown) and a processing unit (not shown) that is connected to the memory unit. The memory unit could be of the non-volatile kind, such as a flash memory or a RAM (Random Access Memory). A dedicated, executable computer program with computer instructions may be located in the memory unit. The processing unit is configured to carry out the instructions of the computer program. The computer program could be recorded on a carrier, typically a computer readable medium, prior to being loaded onto the memory unit. Alternatively, it could be preinstalled in said memory unit. The disclosed embodiments of the method are performed when the computer programs are executed such that above-mentioned instructions are carried out by the suitably configured processing unit. A control panel 17 is associated to the control cabinet 16. The control panel 17 is the interface between the operator of the device and the device 1.

Optional unit 12 is a buffer unit which renders the vaporization process at hand more stable by compensating for eventual disturbances in the feed of urine.
Fig. 4B is a flow chart of the method for isolation of material, in particular medical substances, present in dissolved state in human or animal urine according to one embodiment of the invention. The method is used in a device 1 that has been described in connection with Figs. 1-3. The device 1 according to the invention may comprise an urease dosing unit for adding of urease to said vaporization

chamber 6. This adding of urease may be done before any waste from the vaporization chamber is received by the waste container 9, the waste being generated in the vaporization chamber through vaporization of urine. The waste container 9 being in fluid communication with said vaporization chamber 6. The urease dosing unit may be arranged internally of the device 1 or externally of the device or at least one urease dosing unit may be arranged internally of the device and at least one urease dosing unit may be arranged externally of the device.

The method flow chart in Fig. 4B according to the invention comprises following steps: receiving S10 urine, transferring S20 the received urine into the vaporization chamber 6; exposing S40 the urine to temperatures sufficient to vaporize said urine and to destroy all living microorganisms present in said urine; evacuating S60 the vapor generated in the vaporization chamber; reducing S65 the amount of urea in the urine held in the vaporization chamber by exposing said urine to urease; and conveying S90 waste generated in the vaporization chamber through vaporization of urine to the waste container 9, once said waste meets a predetermined criteria or after a predetermined time period.

The step S65 of reducing the amount of urea in the urine held in the vaporization chamber 6 by exposing said urine to urease is performed by means of arranging an urease dosing unit internally or externally of the device 1. The technical effect of adding urease to the urine, preferably, by addition of external urease, this usage of urease is able to reduce the production of waste from the device 1 to a great extent.

The device 1 further comprises a protective structure 21 (shown in Figs. 2a and 2b) which hinders liquid (such as aerosol drops) but allows vapor to pass through. Figs 2a and 2b show cross-sectional views of two embodiments of the protective structure 21 according to the present invention. The structure 21 creates a physical obstacle that hinders liquid (such as aerosol drops), but allows vapor to pass through. There is an optional condensation unit 24 to cool vapor from the vaporization chamber 6. The protective structure 21 is arranged in connection with

a vapor evacuation unit 7 and is in fluid communication with the vaporization chamber 6. The protective structure 21 is vapor permeable. The protective structure 21 is vapor permeable and prevents passage of mist-building droplets (aerosols). The protective structure 21 is liquid-hindering but vapor-pervious.

Non-limiting examples of the protective structure 21 may in some embodiments comprise a plurality of porous, deformable filling bodies shown in Fig. 2a. By way of example, such bodies may be made of steel wool or polymer sponge or a corresponding porous material that hinders liquid but is permeable to gas. In further embodiments, the protective structure may comprise a metal net with a specified distance between the threads, such as a demister. In this context and as is known to the person skilled in the particular technical field, these bodies could be embodied and arranged in many different ways. Hence, typical filling bodies may also include shapes such as saddles or rings, which may comprise packing, e.g. structured or knitted packing. Simple baffles are also envisaged. An alternative embodiment of the protective structure 21 is shown in Fig. 2b. According to this embodiment, the protective structure 21 may comprise a number of substantially two-dimensional, rigid objects for instance extending radially.

According to the invention, the device 1 may be provided with more than one protective structure 21. In other embodiments, the device 1 may be provided with at least one protective structure 21 comprising a demister or may be provided with at least one protective structure 21 being a demister in itself. In yet another embodiment, the device 1 may be provided with at least one protective structure 21 comprising a demister and at least one protective structure 21 being a demister in itself. In still other embodiments, the device 1 may be provided with at least one protective structure 21 comprising more than one demister or may be provided with more than one protective structure 21 being a demister in itself.

The technical effect to be achieved by introducing a protective structure 21 according to the present invention is the prevention of small, mist-building droplets (aerosol) that are created in the vaporization process, and possibly contain

chemicals that are intended to be isolated in the vaporization chamber 6, from leaving the latter. Vapor that passed through the protective structure 21 may optionally condense in a condensation unit 24 for subsequent release into the waste water system.

Hence, the technical effect to be achieved by introducing at least one protective structure 21 according to the present invention is the prevention of small, mist-building droplets (aerosol) that are created in the vaporization process and dragged along with the generated vapor, e.g. by adhering to droplets and/or by being part of the water forming the droplet at vaporization. The droplets/aerosol carried by the vapor comprise non-fluidic, i.e. solid, fractions in the form of chemicals comprising medical substances, such as antibiotics, cytostatics and non-steroid, anti-inflammatory drugs intended to be isolated in the vaporization chamber 6, which substances then are prevented from leaving the latter and ending up in the drain and let out according to the invention.

Surprisingly, test results presented in Example 1 below show a 50-fold increase in isolation efficiency of aerosol/droplet carried substances in the vaporization chamber 6 when at least one protective structure 21 was utilized, compared to when no protective structure 21 was used.

Fig. 3 highly schematically shows one embodiment of the device with a urine receiving unit 3, vaporization chamber 6, means 15 for control of the pressure in the vaporization chamber, e.g. by achieving a below atmospheric pressure, means 31 for heating of the vaporization chamber 6, evacuating the vapor generated in the vaporization chamber through the vapor evacuation unit 7, prohibiting liquid, in particular aerosol/droplets comprising unwanted medical substances as defined above, to leave the vaporization chamber by the protective structure 21, once the material still present in the vaporization chamber 6 meets a predetermined criteria or after a predetermined time period, evacuating this material from the vaporization chamber to the waste container 9.

Furthermore, the device comprises a condensation unit 24, an analytical unit 27 to evaluate the cleanness of the vapor, a pump 15 to generate below atmospheric pressure and effluent to the sewer system. In addition, there are several valves V1 to V7 that, together with the pump, are used to create differences in internal pressure at least between the urine receiving unit, the vaporization chamber 6, the waste container 9 and the effluent to the sewage system such that the created pressure differences at least assist in transferring content at least between the urine receiving unit 3, the vaporization chamber, the waste container 9 and the sewage effluent.

The analytical unit 27 is configured to determine the amount of impurities present in the condensed vapor either through measuring conductivity of the condensed vapor and/or by determining its absorbance. The analytical unit 27 is arranged either in connection with or downstream of the condensation unit 24. Further, the device may feature a pressure gauge 25, a temperature sensor 26, a further means for measuring conductivity and/or absorbance, e.g. via the analytical unit 27, a first drain 28, cooling water 29, a sample 32, a second drain 33 and level sensors N1-N2. The valves V1 to V7 that are adapted to aid and enable control av fluid; waste and vapor flow in the device 1 are not explained in detail as use of such valves is common knowledge for the skilled person.

Once the waste container 9 is filled, it is removed and its content incinerated destroying all isolated harmful substances, in particular medical substances that otherwise would have been let out into the sewage together with the condensate.

Fig. 4A is a flow chart of the method for isolation of material, in particular medical substances, present in dissolved state in human or animal urine according to one embodiment of the invention. The method is used in a device that has been described in connection with Figs. 1-3. The method comprises receiving urine S10, transferring the received urine into a vaporization chamber 6 (S20), exposing the urine present in the vaporization chamber to a controlled pressure (e.g. below atmospheric pressure) S30, produced by the pump 15, and simultaneously

therewith, exposing the urine to a temperature sufficient to vaporize said urine S40 and to destroy living microorganisms present in the urine; adding S50 a non-corrosive antifoaming agent to the vaporization chamber in order to reduce foaming; evacuating the vapor generated in the vaporization chamber S60; leading the evacuated vapor through the protective structure 21 hindering liquid, in particular aerosol droplets, but allowing vapor to pass through S70; condensing S80 vapor downstream of the protective structure; and once the material still present in the vaporization chamber meets a predetermined criteria or after a predetermined time period; evacuating this material/waste from the vaporization chamber S90.

The device 1 according to the invention comprises at least one heater 40 for heating at least one protective structure 21 and/or at least one demister 21 to a temperature sufficient to prevent vapor from condensing at the protective structure. The method according to the invention comprises a step S100 of heating at least one protective structure 21 to a temperature sufficient to prevent vapor from condensing at each protective structure, e.g. by means of at least one heater 40 for each protective structure and/or demister 21. The heater 40 may heat the protective structure and/or demister 21 indirectly and/or directly to a temperature sufficient to prevent vapor from condensing on and/or in and/or at the protective structure and/or on and/or in and/or at the demister 21.

According to one embodiment of the invention, at least one heater 40 is arranged externally of the device 1 suitable for isolation of material. In another embodiment, at least one heater 40 is arranged externally of at least one protective structure/demister 21 of the device 1. In yet another embodiment, at least one heater 40 is integrated in at least one protective structure/demister 21 of the device 1. The same number of and operational and physical/technical coupling combinations of heater/-s 40 and/or protective structure/-s and/or demister/-s 21 are applicable for usage in the method according to the invention.

In one embodiment of the invention, the heating to prevent aerosol and/or droplets comprising substances, in particular medical ones, from passing through the protective structure 21 and increase the vaporization rate of the device 1 at the same time may be done by directly heating the protective structure. In an embodiment of the invention, the heating to prevent the above aerosol/droplets from passing through the protective structure and increase the vaporization rate of the device at the same time may be done by indirectly heating the protective structure. In another embodiment of the invention, the heating to prevent the above described aerosol/droplets from passing through the protective structure and increase the vaporization rate of the device 1 at the same time may be done by indirectly heating the demister 21, if the protective structure comprises a demister, by increasing the temperature of the protective structure so that the protective structure by means of radiant heat and/or thermal conductivity and/or convection and/or induction heating. Another embodiment of the invention achieves the heating to prevent the above defined aerosol/droplets from passing through the protective structure and increase the vaporization rate of the device 1 at the same time by directly heating the demister 21, if the protective structure comprises a demister or is in itself a demister, by increasing the temperature of the demister by means of thermal conductivity and/or induction heating.

At least one or more protective structures 21 and/or at least one or more demisters 21 is utilized in the device 1 and method according to the invention to maintain or even improve the prevention of aerosols/droplets comprising substances, in particular medical ones, from passing through the protective structure/demister 21 and increase the vaporization rate of the device 1 at the same time.

As discussed above in conjunction with Fig. 1, the received urine may also be collected in the auxiliary heating unit/ microorganism sterilization unit prior to transferring it to the vaporization chamber 6. This auxiliary heating unit is arranged to heat up the received urine to a temperature exceeding 60 ^{o}C for a time that is sufficient to kill microorganisms in step S40. In this way, bacteria and

viruses that may be present in the urine can be destroyed. As discussed above in conjunction with Figs. 2a and 2b, the generated vapor is led through the vapor-pervious, protective structure 21 in step S70, and condensed downstream of said protective structure in step S80. The condensed vapor has no or at least reduced or even a very low concentration of unwanted substances, in particular medical substances, such as the medical ones described in this disclosure.

The amount of impurities, i.e. non-water molecules, in the condensed vapor may subsequently be determined. By way of example, this may be achieved through measuring conductivity of the condensed vapor or by determining its absorbance. Hereby, a suitable way of continuously controlling the quality of the isolation process is obtained. The calculated data may be registered, and presented to the device operator via the control panel so as to enable online monitoring of the precision, i.e. the quality, of the isolation process. In order to facilitate proper control of the process, measurements may additionally be carried out upstream in the process, for example prior the vaporization chamber 6. Such measurements may be used to assist the control of dosing units such as urease dosing unit. The above mentioned measurements is preferably carried out by the analytical unit 27.

In a further embodiment (not shown), a non-corrosive antifoaming agent is added in order to reduce foaming. Normally said agent is added to the boiling urine.

In an alternative embodiment (not shown), the transfer of the urine between the urine receiving unit 3, the vaporization chamber 6 and the waste receiving container 9, and optionally at least the auxiliary heating unit 31, is gravity-assisted. Accordingly, in this embodiment all the receptacles are positioned along a vertical line such that an outlet of an upper receptacle, e.g. the vaporization chamber, is arranged in connection with an inlet of a lower receptacle, in the exemplary case the receiving container. The opening and closing of the valves arranged between the receptacles could then be actuated by the weight of the fluid content of each receptacle. An extremely simple solution, not depending on

the functioning of neither the control unit nor the pump for transferring of the content of the respective receptacle is hereby obtained.

It is to be understood that the device and/or the method according to any one of the above discussed embodiments of the present invention may without departing from the original inventive concept be used outside of the hospital environment, by way of example on a cattle or pig farm or in connection with a waste treatment plant. Obviously, each such application would be a scaled-up version of the device intended for hospital use.

Example 1

Frozen MIS seq-opt E Coli are placed on an agar plate and incubated over night at 37 degrees C. The next day, one bacterial colony is placed in liquid growth medium. One day later 100 microliters are placed on several agar plates, respectively. On each of these plates, a mast disc impregnated with 20 microliters Ciprofloxacine solution was placed. LB agar plates (Sigma Aldrich) 35 g/liter, LB Broth 20 g/l.

Five control discs with 100, 10, 1, 0.1, and 0.01 mg/l were prepared. In addition, urine containing Ciprofloxacine (100 mg/l) was processed in the device. Four samples were tested in the above bacterial model.

Sample 1: Antibacterial effect by control Ciprofloxacine solution (100 mg/l).
Sample 2: Antibacterial effect by condensed vapor from the device without a protective structure.
Sample 3: Antibacterial effect by condensed vapor from the device with a protective structure.
Sample 4: Antibacterial effect by the remaining solution in the vaporization chamber.

The next day, the size of the bacteria-free ring around the Ciprofloxacine-impregnated mast disc was evaluated.

Results:

Ciproflaxine (mg/l)	Bacterial inhibition zone (mm)	SD
100	36.7	1.5
10	30.3	1.2
1	21.7	1.2
0.1	9	1
0.01	0	0
Sample 1	37	0
Sample 2	27	1.1
Sample 3	11	0.6
Sample 4	41	1.5

Liquid that passed through the device that lacked protective structure (Sample 2) had a bacterial inhibition zone of 26 mm, which approximately corresponds to 5 mg/l Ciproflaxine.

Liquid that passed through the device that employed a protective structure (Sample 3) had a bacterial inhibition zone of 11 mm, which approximately corresponds to 0.1 mg/l Ciproflaxine. Conclusively, the presence of a protective structure reduced the antibiotic concentration in the condensed vapor by about 50 times, demonstrating the importance of the protective structure to obtain an effective isolation of substances by the device. Consequently, the invention provides a great variety of possible designs and adaptation of a device for isolation of material present in urine.

The teaching of this invention has numerous advantages. Different embodiments or implementations may yield one or more of the following advantages. It should be noted that this is not an exhaustive list and there may be other advantages not described herein. One advantage of the teaching of this application is that it provides a great flexibility in designing and operating the disclosed system.

Moreover, due to its flexibility and limited space requirement the invention may be utilized in existing industries, which do not already have such an inventive system.

CLAIMS

1. A device (1) suitable for isolation of material, such as medical substances, present in dissolved state in human or animal urine, said device comprising:
- a urine receiving unit (3),
- a vaporization chamber (6) being in fluid communication with said urine receiving unit (3),
- a vapor evacuation unit (7) suitable for receiving vapor from said vaporization chamber (6),
- a condensation unit (24) suitable for receiving vapor from said vapor evacuation unit (7) via said protective structure (21),
- means, such as a pump (15), for reducing pressure in said vaporization chamber (6) below atmospheric pressure,
- means for heating the vaporization chamber (6),
- a dosing unit for adding of a non-corrosive anti-foaming agent to said vaporization chamber (6), and
- a waste container (9) for receiving waste generated in the vaporization chamber (6) through vaporization of urine, the container (9) being in fluid communication with said vaporization chamber (6), said device being **characterized in that**
said vapor evacuation unit (7) comprises a protective structure (21) arranged in fluid communication with said vaporization chamber (6) and
in that said protective structure is vapor permeable and prevents passage of mist-building droplets from the vaporization chamber.

2. A device (1) according to claim 1, wherein said device further comprises a urease dosing unit.

3. A device (1) according to claim 2, wherein said urease dosing unit is arranged externally of the device (1) suitable for isolation of material.

4. A device (1) according to any preceding claim, wherein said device further comprises an analytical unit (27) arranged downstream of the protective structure

(21), said analytical unit being adapted to determine the amount of impurities in a condensate derived from said condensation unit (24).

5. A device according to claim 4 wherein said analytical unit (27) determines the amount of impurities by measuring conductivity.

6. A device according to claim 4, wherein said analytical unit (27) determines the amount of impurities by measuring absorbance.

7. A device (1) according to any of the preceding claims, wherein said device further comprises a microorganism reduction unit (12) arranged so as to be in fluid communication with the urine receiving unit (3) and with the vaporization chamber (6), said microorganism reduction unit (12) being arranged to heat up the received urine to a temperature exceeding 60 ^{0}C.

8. A device (1) according to any preceding claim, wherein said non-corrosive anti-foaming agent comprises at least one of paraffins, fatty acids and tensids.

9. A device (1) according to any preceding claim, wherein said waste container (9) is sealable and exchangeable.

10. A device (1) according to any preceding claim, wherein said protective structure (21) comprises a maze structure, a plurality of porous deformable filling bodies, or polymer sponge.

11. A device (1) according to any preceding claim, wherein said device (1) is dimensioned and assembled as a unit suitable for mobility within an indoor environment such as a hospital.

12. A device (1) according to any of claims 1 to 11, wherein the protective structure (21) is at least one demister or comprises at least one demister.

13. A device (1) according to any of the preceding claims, wherein the device comprises a heater (40) adapted to heat the protective structure (21) for preventing vapor from condensing at the protective structure.

14. A device (1) according to claim 13, wherein the heater (40) is arranged externally of the device (1) suitable for isolation of material.

15. A device (1) according to claim 13, wherein the heater (40) is arranged externally of the protective structure (21) or integrated in the protective structure.

16. A method for isolation of material, such as medical substances, present in dissolved state in human or animal urine, wherein said method comprises:

- receiving (S10) urine,
- transferring (S20) the received urine into a vaporization chamber (6),
- exposing (S30) the urine present in the vaporization chamber (6) to a first below atmospheric pressure, and simultaneously therewith exposing (S40) the urine to temperatures sufficient to vaporize said urine,
- adding (S50) a non-corrosive antifoaming agent to said vaporization chamber (6) in order to reduce foaming,
- evacuating (S60) the vapor generated in the vaporization chamber (6),
- leading (S70) the evacuated vapor through a protective structure (21) which hinders liquid but allows vapor to pass through,
- condensing (S80) vapor downstream of said protective structure (21), and
- conveying (S90) waste generated in the vaporization chamber (6) through vaporization of urine to a waste container (9), once said waste meets a predetermined criteria or after a predetermined time period.

17. A method according to claim 16, wherein said method further comprises:

- heating (S100) the protective structure (21) to prevent vapor from condensing at the protective structure.

18. A method according to claim 16 or 17, wherein said method further comprises:
    - reducing the amount of urea in the urine held in the vaporization chamber (6) by exposing said urine to urease.

19. A method according to any of claims 16 to 18, wherein said method further comprises:
    - condensing the vapor downstream of said protective structure (21) so that the amount of impurities in the evacuated vapor is determined using a condensate of the vapor that passed through said protective structure (21).

20. A method according to claim 19, wherein determining the amount of impurities in the evacuated vapor comprises measuring conductivity and/or absorbance.

21. A method according to any of the claims 16 to 20, wherein said method further comprises:
    - heating up the received urine to a temperature exceeding 60 ^{0}C prior to transferring it further.

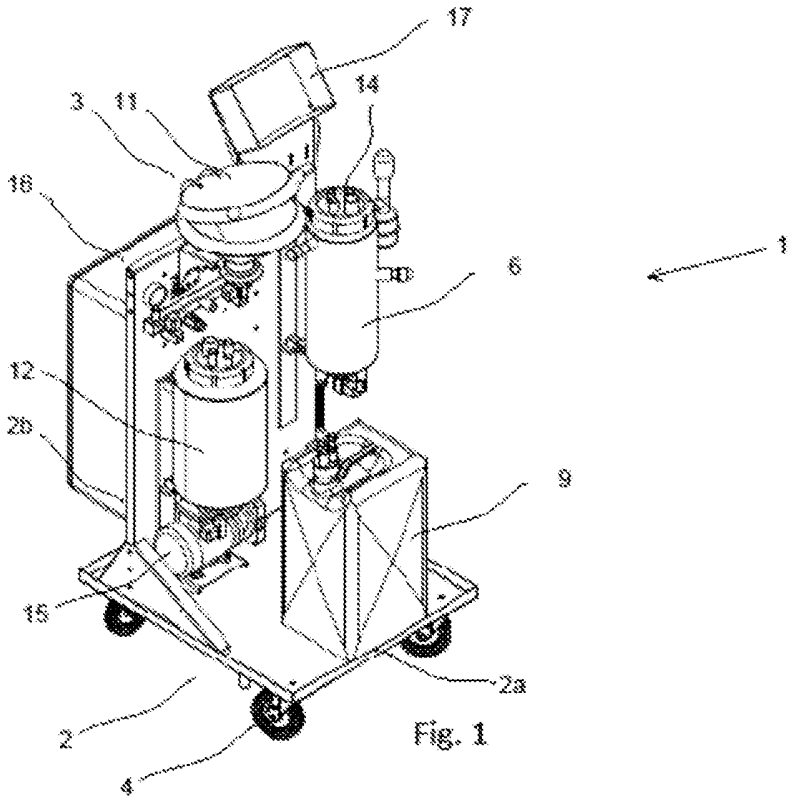

Fig. 1

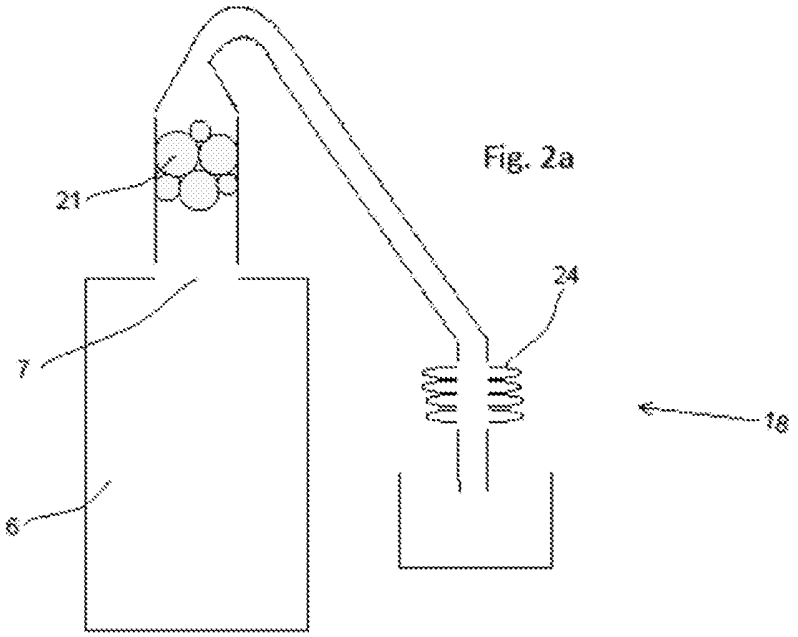

Fig. 2a

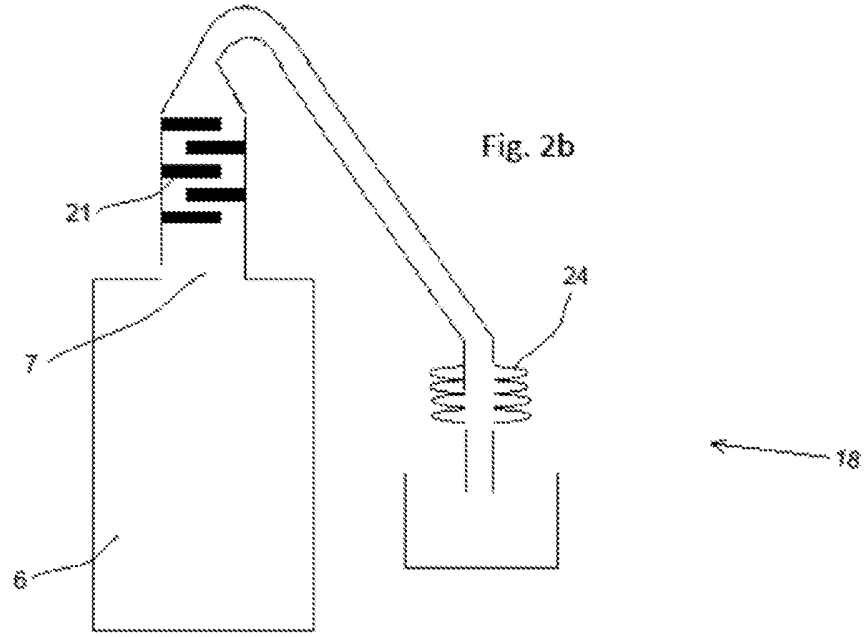

Fig. 2b

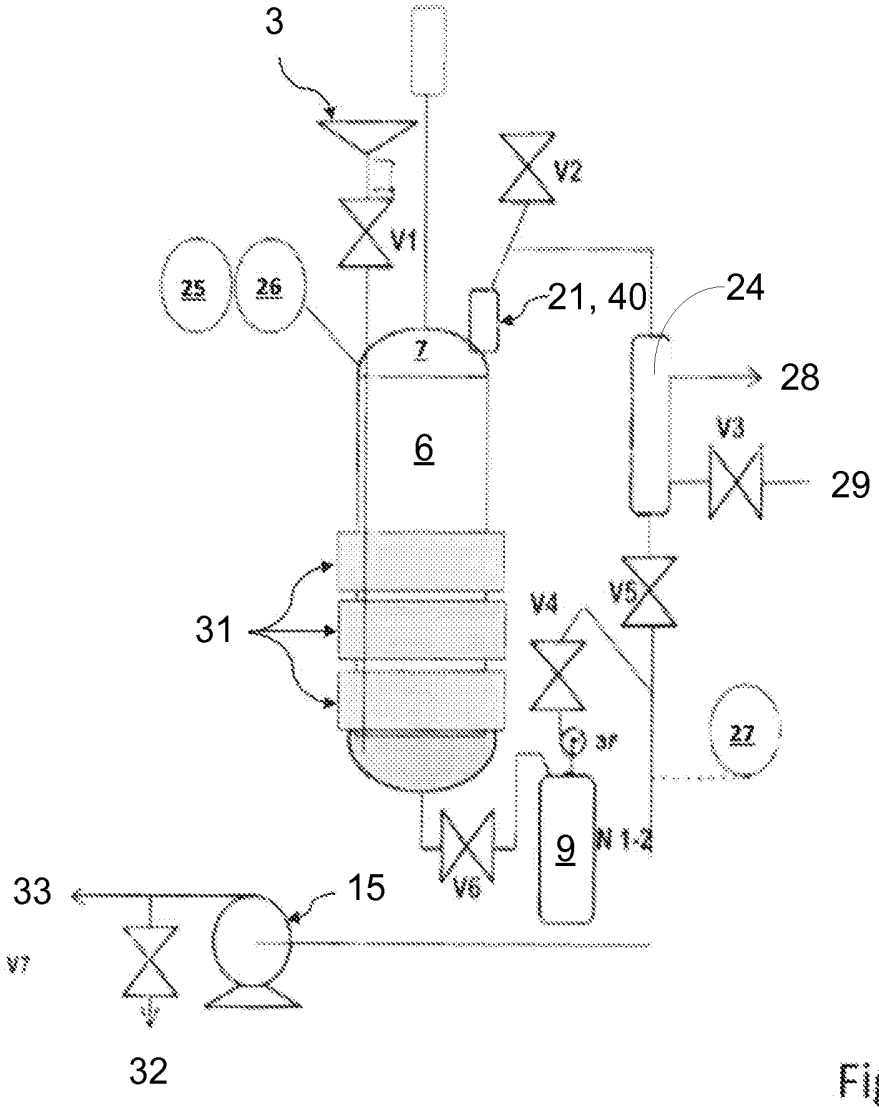

Fig. 3

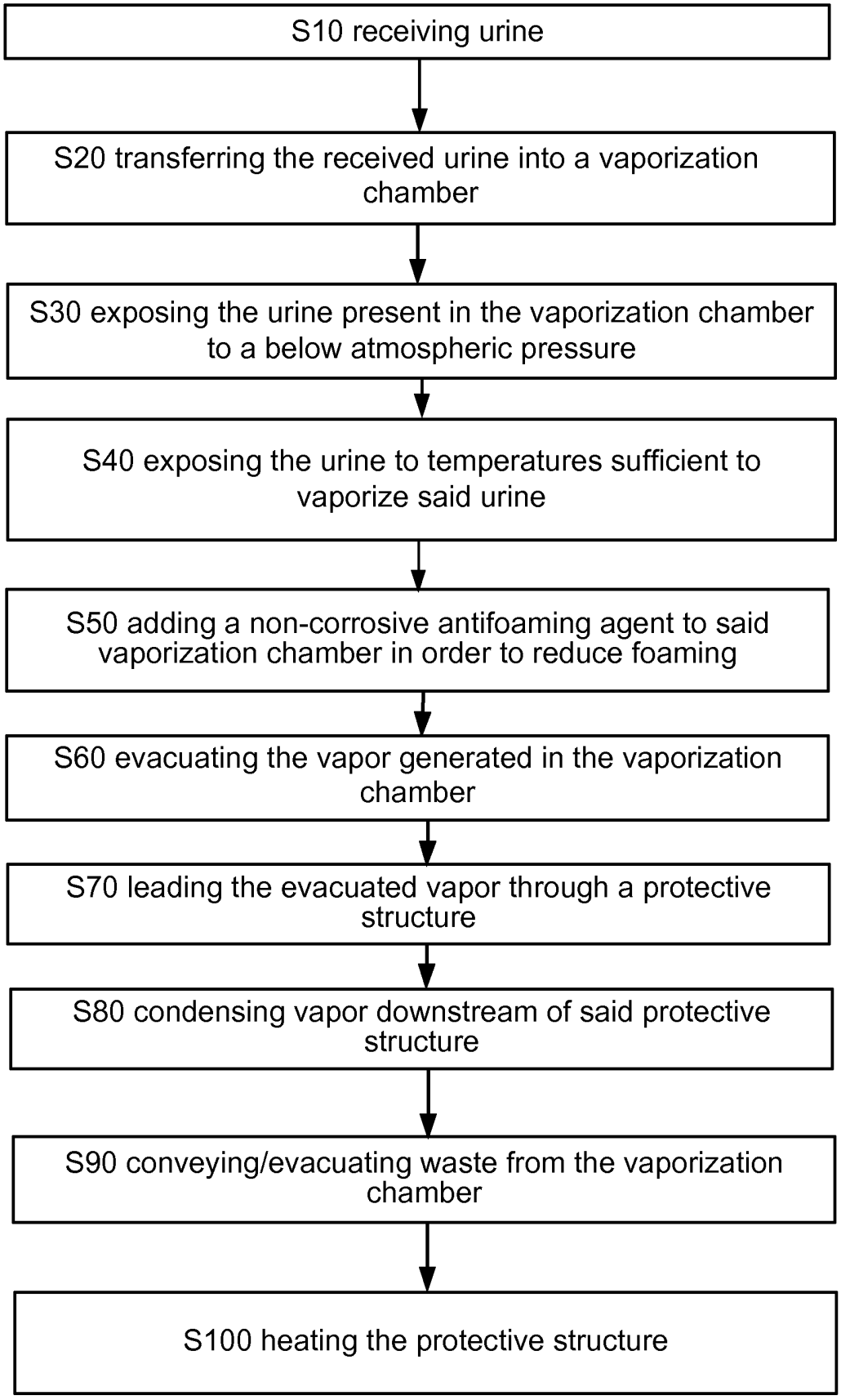
S10 receiving urine
S20 transferring the received urine into a vaporization chamber
S30 exposing the urine present in the vaporization chamber to a below atmospheric pressure
S40 exposing the urine to temperatures sufficient to vaporize said urine
S50 adding a non-corrosive antifoaming agent to said vaporization chamber in order to reduce foaming
S60 evacuating the vapor generated in the vaporization chamber
S70 leading the evacuated vapor through a protective structure
S80 condensing vapor downstream of said protective structure
S90 conveying/evacuating waste from the vaporization chamber
S100 heating the protective structure

Fig. 4A

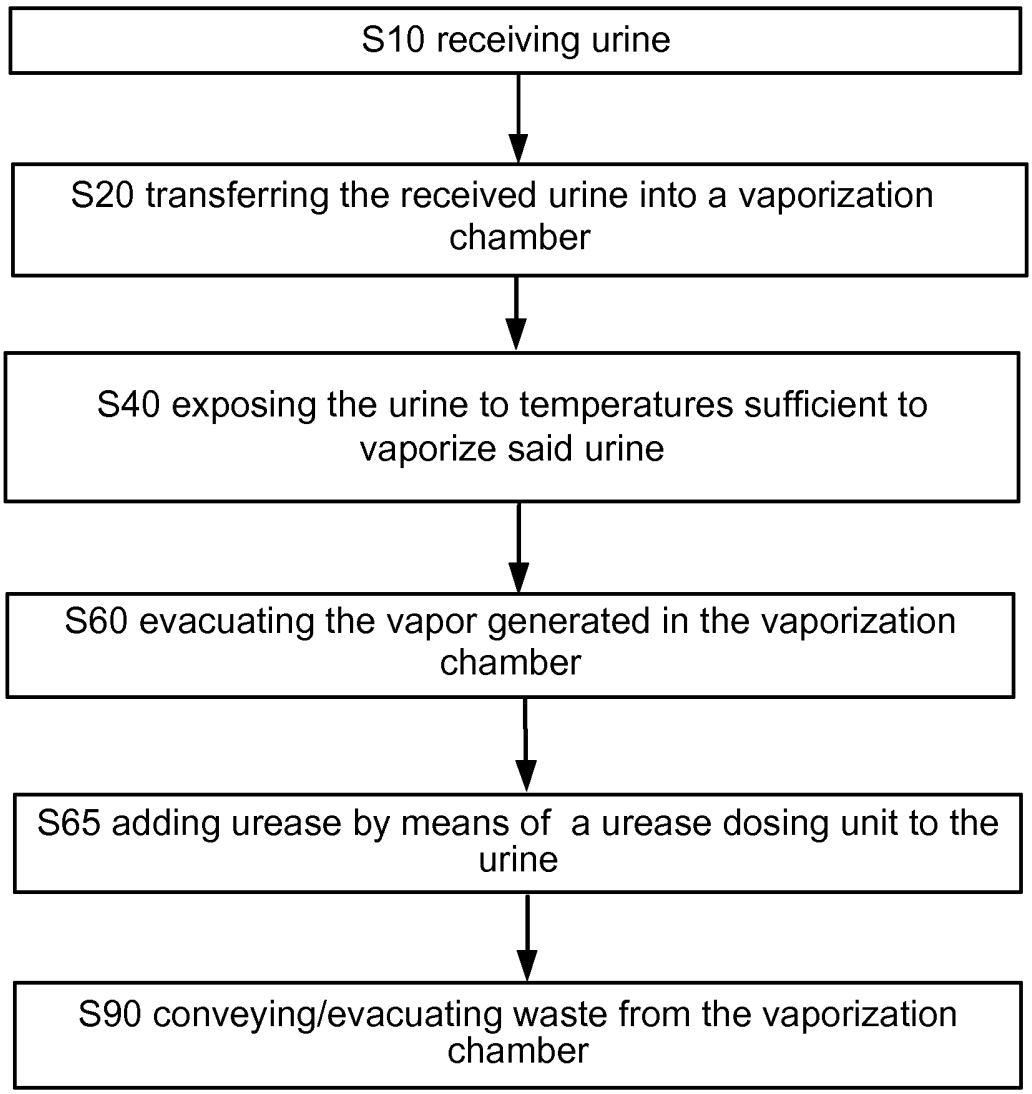
S10 receiving urine
S20 transferring the received urine into a vaporization chamber
S40 exposing the urine to temperatures sufficient to vaporize said urine
S60 evacuating the vapor generated in the vaporization chamber
S65 adding urease by means of a urease dosing unit to the urine
S90 conveying/evacuating waste from the vaporization chamber

Fig. 4B