

DEVICE FOR HAND DISINFECTION

FIELD OF THE INVENTION

- 5 The invention relates to a system for producing and releasing a solution suitable for use in human hygiene, in particular to a point-of-use electrochemical system for production and release of a solution suitable for washing and disinfecting hands.

BACKGROUND OF THE INVENTION

10

Devices for the release of solutions or gels suitable for washing hands are present in several public places in addition to domestic environments; it is an increasingly common practice to fill common liquid soap dispensers with products containing disinfecting substances, for example having antiseptic properties, in order to get an improved protection in crowded or high-transit public places (airports and train stations, highway service stations, theatres, cinemas and venues for sports events). Alternatively, disinfecting solutions are provided in disposable soaked tissues, with the inconvenience of involving a waste product that needs to be subsequently dumped. Although useful, gels and solutions of common use do not offer a wide-spectrum protection; broad spectrum antiseptic agents known in the art are in fact characterised by an excessive cost or by an insufficient or scarcely reproducible shelf-life. While in many cases the protection provided by a normal antibacterial product may be considered acceptable, there are other environments where a broader spectrum protection would be highly desirable, also for the sake of preserving public health. For example, this is the case with hospitals or clinics where expensive specific products are commonly used, but also with places where food is processed (e.g. kitchens of public restaurants, butcheries, bakeries and confectioneries) or distributed (e. g. canteens and restaurants).

15
20
25

The need for providing an efficient and cheap system for hand disinfection in a wide range of environments has been hence identified.

SUMMARY OF THE INVENTION

5

Various embodiments of the present invention are described in the appended claims.

In one embodiment, the invention consists of a device suitable for producing and nebulising an oxidant solution having disinfecting properties, comprising a rigid body provided with a recess for the insertion of the hands, an electrochemical cell equipped with a timer suitable for producing an oxidant solution by electrolysis of an aqueous electrolytic medium during a predefined time, means for nebulising said oxidant solution inside said recess for hand insertion, at least one probe suitable for detecting hand insertion inside said recess and an actuator suitable for commanding the upload of a predefined volume of said aqueous electrolytic medium inside said electrochemical cell and the timed execution of said electrolysis, wherein the probe and the nebulising means are connected to an electronic control board commanding the nebulisation of the product oxidant solution based on the detection of the probe. The device of the invention may be used for example to produce in an efficient and cost-effective way oxidant solutions containing species such as active chlorine, ozone or peroxides, characterised by a high antibacterial action at the time of production but having a much too sharp time decay to allow their concentration being guaranteed even in the short term. For example, active chlorine may advantageously be used in form of a hypochlorite and hypochlorous acid mixture at equilibrium, at a concentration preferably comprised between 20 and 300 ppm; below 20 ppm, the antibacterial action results in fact less efficient, while at too high concentrations the aggressive action may result excessive for the human skin. A solution containing 300 ppm of active chlorine would nevertheless have an insufficient stability to be stored and supplied as a product for

10
15
20
25

dispenser refill, unless either stabilised with caustic soda at concentrations unsuitable for application on human skin or provided in form of organic species characterised by a slow release of chlorine, which are more toxic and remarkably more expensive. The in-situ point-of-use production of an oxidant solution containing active chlorine can have the advantage of being directly obtained at a concentration suitable for use with no stabilisation needed. Oxidant solutions containing active chlorine produced by electrolysis of alkali chloride brines, for example sodium chloride, may also contain a small amount of active oxygen, for example ozone or peroxide traces, which are then quickly decomposed. This can have the advantage of further increasing the efficiency of the antibacterial or biocide action of the product solution.

In one embodiment, the actuator of the device allows uploading a predefined volume of an electrolytic aqueous medium – for example a brine of an alkali metal chloride such as sodium or potassium chloride – to the electrochemical cell and subjecting the same to electrolysis; in one embodiment, the predefined volume of electrolyte is comprised between 1 and 20 ml. In one embodiment, the electrolysis of the electrolytic medium is carried out for a time comprised between 1 and 5 seconds until a suitable concentration of oxidant species, for example from 20 to 300 ppm of active chlorine with optional traces of ozone or peroxides, is attained. In one embodiment, the insertion of the hands in the recess after operating the actuator and the completion of the electrolysis are detected by a suitable probe, which in one embodiment consists of a photocell; when the insertion of the hands is detected, the electronic control board receives the signal of the probe and commands the actuation of the nebulisation means, for example consisting of an atomiser, through which the electrolytically-produced oxidant solution is sprayed on the hands.

In one embodiment, when the actuator is operated for a predefined number of times, for

example 2 to 5 times, with no corresponding hand insertion in the appropriate recess being detected, the electronic control board anyway commands the nebulisation of the produced oxidant solution. This can have the advantage of avoiding that, upon repeatedly operating the actuator commanding the electrolysis of the electrolytic medium, an excessive accumulation of the oxidant solution takes place or the concentration thereof is increased to excessive values. For example, in a cell set up to produce an oxidant solution with an active chlorine concentration of 100 ppm with no possibility of uploading an additional volume of solution after the first electrolyte upload before the product discharge takes place, it is to be avoided that the actuator be operated in a rapid sequence for more than three consecutive times in order to prevent the concentration of active chlorine in the oxidant solution exceeding 300 ppm, which is considered the upper limit of the optimum interval.

In one embodiment, the invention consists of a device suitable for producing and nebulising an oxidant solution having disinfecting properties, comprising a rigid body provided with a recess for the insertion of the hands, an electrochemical cell provided with a timer, suitable for producing an oxidant solution by electrolysis of an aqueous electrolytic medium during a predefined time, means for nebulising said oxidant solution inside said recess for hand insertion, at least one probe suitable for detecting hand insertion inside said recess and an actuator suitable for commanding the upload of a predefined volume of said aqueous electrolytic medium inside said electrochemical cell, the timed execution of said electrolysis, wherein also the electrochemical cell, in addition to the probe and nebulisation means, is connected to an electronic control board which commands the upload of a predefined volume of electrolytic solution, the subsequent timed execution of electrolysis inside the electrolytic cell and the subsequent nebulisation of the product oxidant solution on the basis of the detection of the probe, optionally consisting of a photocell. In this case, the device may not comprise

a further actuator as said function is carried out by the probe suitable for detecting the hand insertion. Also in this case, the predefined volume of electrolyte may be comprised between 1 and 20 ml and the electrolysis of the electrolytic medium may be carried out for a time comprised between 1 and 5 seconds until a suitable concentration of oxidant species is attained, for example 20 to 300 ppm of active chlorine, with optional traces of ozone or peroxides.

The composition of the product oxidant solution may be varied by acting on the composition of the aqueous electrolytic medium and on the nature of the electrodes, in particular of the anode, installed in the electrolytic cell, as will be evident to a person skilled in the art. For example, the generation of hypochlorite or hypochlorous acid may be obtained by using diluted sodium chloride brines, optionally acidulated to shift the equilibrium towards the hypochlorous acid species, and titanium anodes activated with catalysts based on oxides of transition metals such as ruthenium, iridium, palladium, titanium, zirconium or tantalum; likewise, it is possible to produce solutions containing ozone (for example starting from tap water with anodes based on mixed oxides of tin and antimony or with deionised water with boron-doped diamond anodes), oxygen peroxide (for example from acid or alkaline electrolytes in cells provided with an air-fed gas-diffusion electrode) or active chlorine and mixed peroxidates such as percarbonate or persulphate (with tap water optionally added with sodium carbonate and boron-doped diamond anodes).

The concentration of the oxidant species in the product solution may be adjusted by acting on the active surface of the electrodes, on the current density, on the electrolysed volume and on the electrolysis duration; a person skilled in the art can easily determine the most favourable parameters for the preparation of the oxidant solution in a suitable composition range. The generation of oxidant solutions containing active chlorine,

mainly in the form of hypochlorite, with optional traces of active oxygen, can have the advantage of providing a product with optimum disinfecting properties starting from an extremely cheap and handy electrolytic medium with reduced electrolysis times also for small size electrolytic cells: for example, a load of 6 ml of a simple sodium chloride solution at 1-10 g/l can generate 20-300 ppm of active chlorine in a time range of 1 to 2 seconds with a total anodic area of 6 to 21 cm² at a current density of 1 to 2 kA/m². The sodium chloride solution may be uploaded to the device by means of a dispenser bottle like those commonly used for drinking water distribution, housed inside the rigid body or positioned externally thereto, for example above the device, and put in fluid communication with the cell. In an alternative embodiment, the sodium chloride solution may be fed through disposable cartridges. In one embodiment, the sodium chloride brine may be prepared at the time of use, for example by dissolving a pre-dosed amount of sodium chloride, optionally as powder or tablet, in a predefined volume of water.

In one embodiment, the device is powered from grid, rechargeable batteries or solar panels, taken alone or in mutual combination.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, figure 1 shows the scheme of an embodiment of the device for hand disinfection according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

In the embodiment shown in figure 1, a device for hand disinfection comprises a rigid body **1** provided with a recess for hand insertion **2** of suitable dimensions; inside rigid

body **1**, an actuator **6**, for example a start button optionally connected to a central process unit, commands the upload of a predefined quantity of electrolyte, for example a salt solution contained in a dispenser bottle **7**, to an electrochemical cell **4** and the subsequent timed execution of an electrolytic process inside the same cell **4** at a predefined current density. Inside recess **2** a suitable probe, for example a photocell **3**, detects the hand insertion and sends a signal to an electronic control board **8**, which in turn activates the nebulisation means, for example consisting of an atomiser **5**, in communication with the outlet of electrochemical cell **4** and fed with the product of the timed electrolysis consisting of an oxidant solution containing species with high antibacterial activity at a suitable concentration.

Some of the most significant results obtained by the inventors are described in the following example which is not intended to limit the extent of the invention.

EXAMPLE

A device equivalent to the one illustrated in figure 1 was equipped with an undivided electrolytic cell provided with titanium anodes coated with a mixture of oxides of titanium, palladium, ruthenium and iridium, arranged face-to-face at a distance of 0.15 mm and characterised by a total surface of 21 cm². The cell was fed with a solution containing 4 g/l of sodium chloride contained in a dispenser bottle positioned above the rigid body and connected thereto by means of a calibrated loading device, commanded by a central process unit. The cell was also provided with an outlet for the gaseous by-products, interfaced to a relief valve engaged on the upper surface of the rigid body. The process central unit was set to alternately operate one of the two electrodes as anode and the other as cathode, reversing the polarity at every next operation of the start button provided as the actuator. The apparatus was run by setting a load volume of

6 ml of electrolyte, varying the duration and current density of the electrolytic process. An electrolysis time of 2 seconds at a 2000 A/m² current density proved sufficient to generate an oxidant solution containing 300 ppm of active chlorine, mostly as hypochlorite ion, together with peroxide traces. In this case, the electronic control board commanding the atomiser was set to discharge the product solution five seconds after pushing the start button, even in case the hand insertion in the apparatus were not detected by the photocell. By reducing the electrolysis time and current density set up in the central process unit, proportionally lower concentrations of active chlorine were obtained, whereupon the electronic board controlling the atomiser could be set to discharge the product oxidant solution after a higher number of idle cycles (for example, after the third consecutive operation of the actuator for concentrations of 100 ppm of active chlorine).

A person skilled in the art can easily make several changes to the described embodiments, without deviating from the scope of the invention; as said before, by acting on the electrolyte composition and the type of electrodes, different compositions of oxidant solution can be easily obtained as needed. It is also possible to substitute the undivided cell of the example, wherein each of the electrodes alternately works as anode and as cathode, with a cell provided with a separator (for example with a ceramic separator or with an ion-exchange membrane) and with non-interchangeable anode and cathode, optionally of distinct formulations. It is also possible to use either the central process unit controlling the electrolysis parameters, or a different central process unit, as the control electronic board of the nebulising means. It is also possible to provide that the control electronic board command the nebulisation of the solution after a predefined time even though the hand insertion is not detected, in order to discharge the unused oxidant solution.

The previous description shall not be intended as limiting the invention, which may be used according to different embodiments without departing from the scopes thereof, and whose extent is solely defined by the appended claims.

- 5 Throughout the description and claims of the present application, the term "comprise" and variations thereof such as "comprising" and "comprises" are not intended to exclude the presence of other elements, components or additional process steps.

10 The discussion of documents, acts, materials, devices, articles and the like is included in this specification solely for the purpose of providing a context for the present invention. It is not suggested or represented that any or all of these matters formed part of the prior art base or were common general knowledge in the field relevant to the present invention before the priority date of each claim of this application.

CLAIMS

1. A device for hand disinfection comprising a rigid body provided with:

- a recess for hand insertion;
- an electrochemical cell provided with a timer, suitable for producing an oxidant solution by electrolysis of an aqueous electrolytic medium during a predefined time;
- means for nebulising said oxidant solution inside said recess for hand insertion;
- at least one probe suitable for detecting hand insertion inside said recess;
- an actuator suitable for commanding the upload of a predefined volume of said aqueous electrolytic medium inside said electrochemical cell and the timed execution of said electrolysis;

said probe and said nebulising means being connected to an electronic control board suitable for commanding the nebulisation of said oxidant solution based on the detection of said probe.

2. The device according to claim 1 wherein said actuator is connected to said electronic board and commanding the nebulisation of said oxidant solution when said actuator is consecutively triggered for a predefined number of times, independently from the detection of said probe.

3. A device for hand disinfection comprising a rigid body provided with:

- a recess for hand insertion;
- an electrochemical cell provided with a timer, suitable for producing an oxidant solution by electrolysis of an aqueous electrolytic medium during a predefined time;

- means for nebulising said oxidant solution inside said recess for hand insertion;
- at least one probe suitable for detecting hand insertion inside said recess; said probe, said electrochemical cell and said nebulising means being connected to an electronic control board suitable for commanding the upload of a predefined volume of said aqueous electrolytic medium inside said electrochemical cell, the execution of said electrolysis and the nebulisation of said oxidant solution based on the detection of said probe.

- 10 4. The device according to any one of claims 1 to 3 wherein said oxidant solution contains 20 to 300 ppm of active chlorine and optional traces of ozone or peroxides.
- 15 5. The device according to claim 4 wherein said predefined volume is 1 to 20 ml.
6. The device according to claim 4 or 5 wherein said predefined time is 1 to 5 seconds.
- 20 7. The device according to any one of the preceding claims wherein said probe suitable for detecting hand insertion is a photocell.
8. The device according to any one of the preceding claims wherein said aqueous electrolytic medium is an alkali chloride brine supplied to said electrochemical cell from a dispenser bottle.
- 25 9. The device according to any one of claims 1 to 7 wherein said aqueous electrolytic medium is an alkali chloride brine supplied to said electrochemical

cell from a disposable cartridge.

10. The device according to any one of the preceding claims equipped with an electrical power supply from grid, rechargeable batteries or solar panels,
5 alone or in mutual combination.

11. A device for hand disinfection substantially as hereinbefore described with reference to the drawing.