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(54) Title of the Invention: **Disinfectant system**
Abstract Title: **A two-part disinfection system comprising chlorine dioxide**

(57) A disinfectant system comprising: a first part comprising a first reagent; a second part, which is miscible with the first, comprising a second reagent; wherein a disinfectant comprising chlorine dioxide is produced when the reagents are mixed; characterised by a dyestuff that oxidises and changes colour in the presence of chlorine dioxide but not hydrogen peroxide and/or peracetic acid. The dyestuff may comprise anthocyanin, anthocyanidin, carmoisine, allura red, tartrazine, xanthene, or Brilliant Blue FCF. The dyestuff may change from coloured to colourless in the presence of chlorine dioxide but not quaternary ammonium compound-based or triamine-based disinfectants. The first reagent may comprise a metal chlorite and the second may comprise an acid. The first part may be in a fluid dispenser 2 and the second part may be absorbed or impregnated in at least one wipe 16. A method of verifying production of chlorine dioxide may be observing a complete and uniform colour change. There may also be a method of determining if a wipe contains chlorine dioxide by illuminating the wipe with a wavelength of light, measuring the intensity, and comparing it to a preset threshold value.

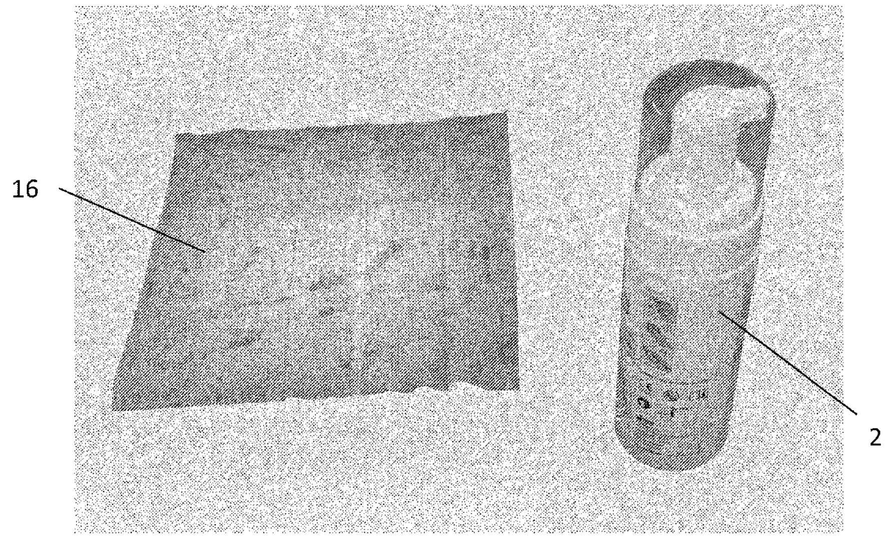

FIG. 3

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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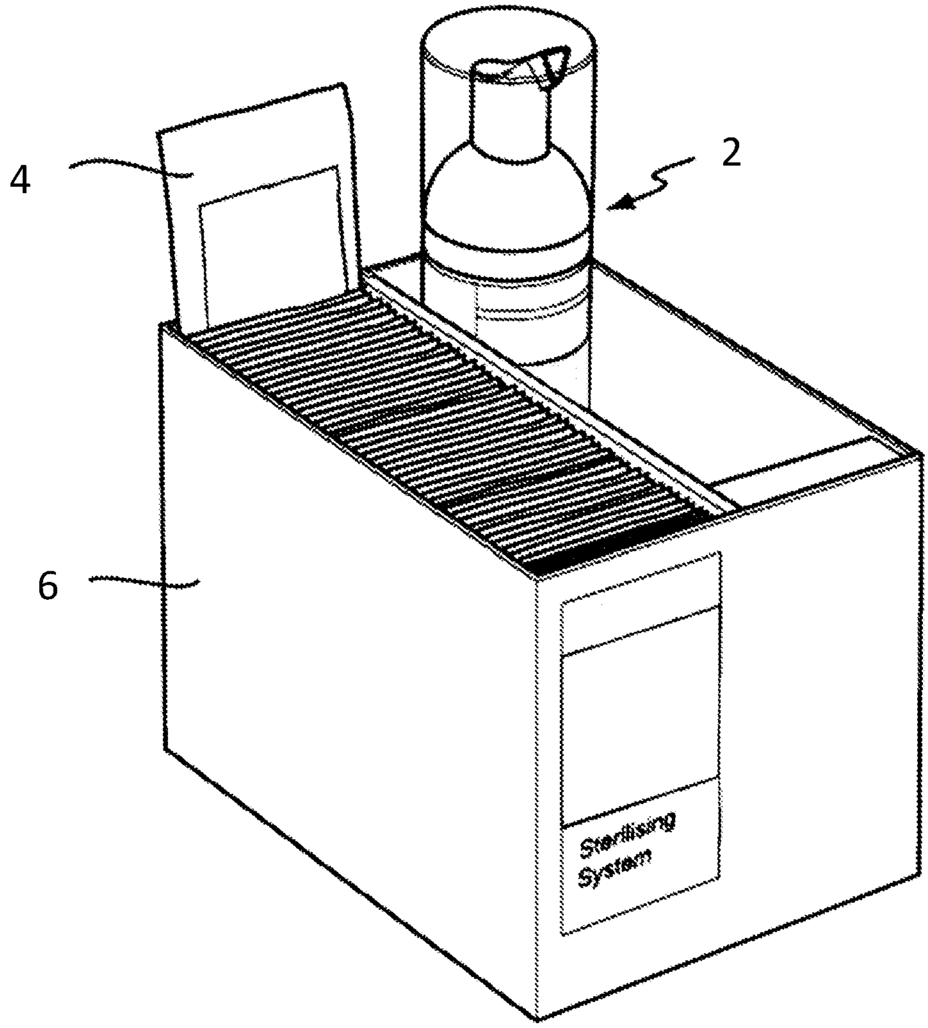


FIG. 1
(PRIOR ART)

29 09 21

29 09 21

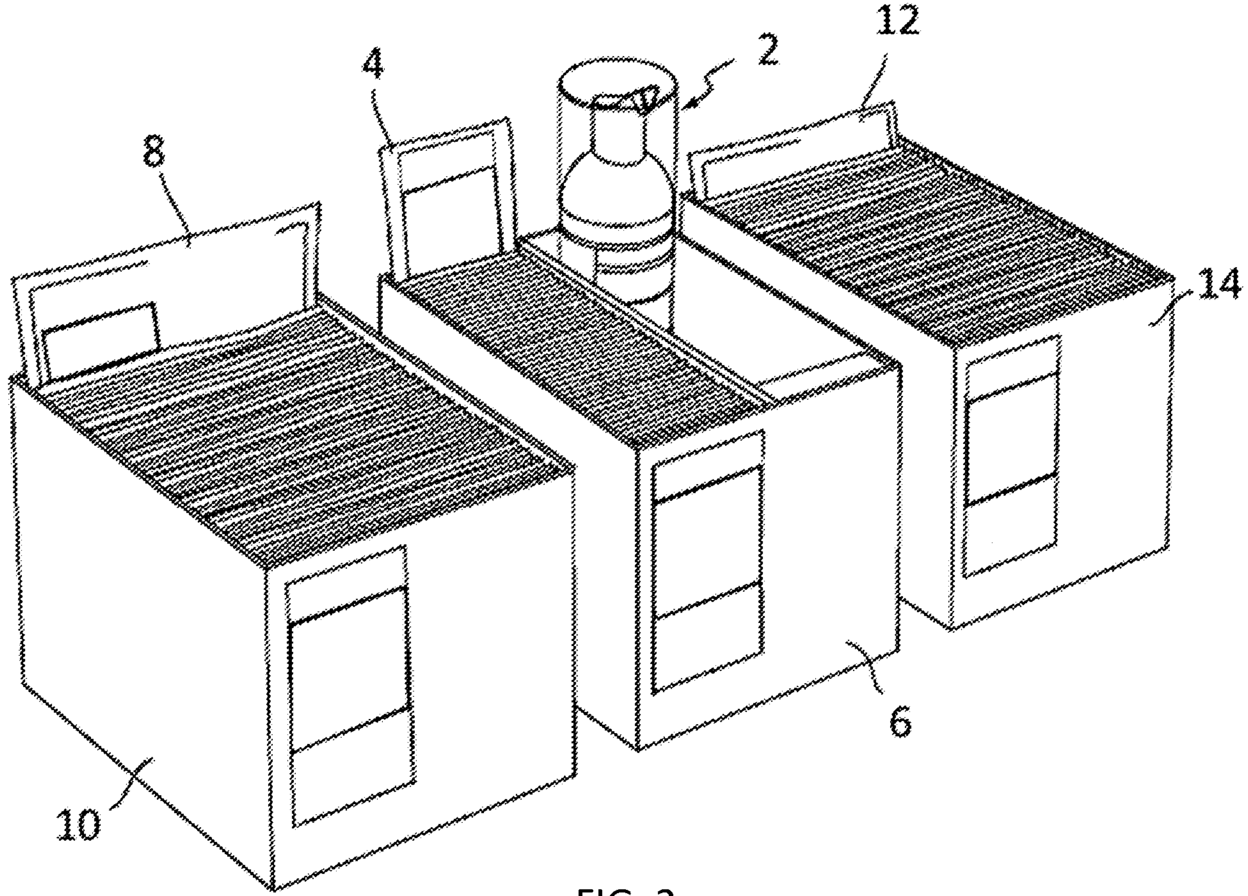


FIG. 2
(PRIOR ART)

29 09 21

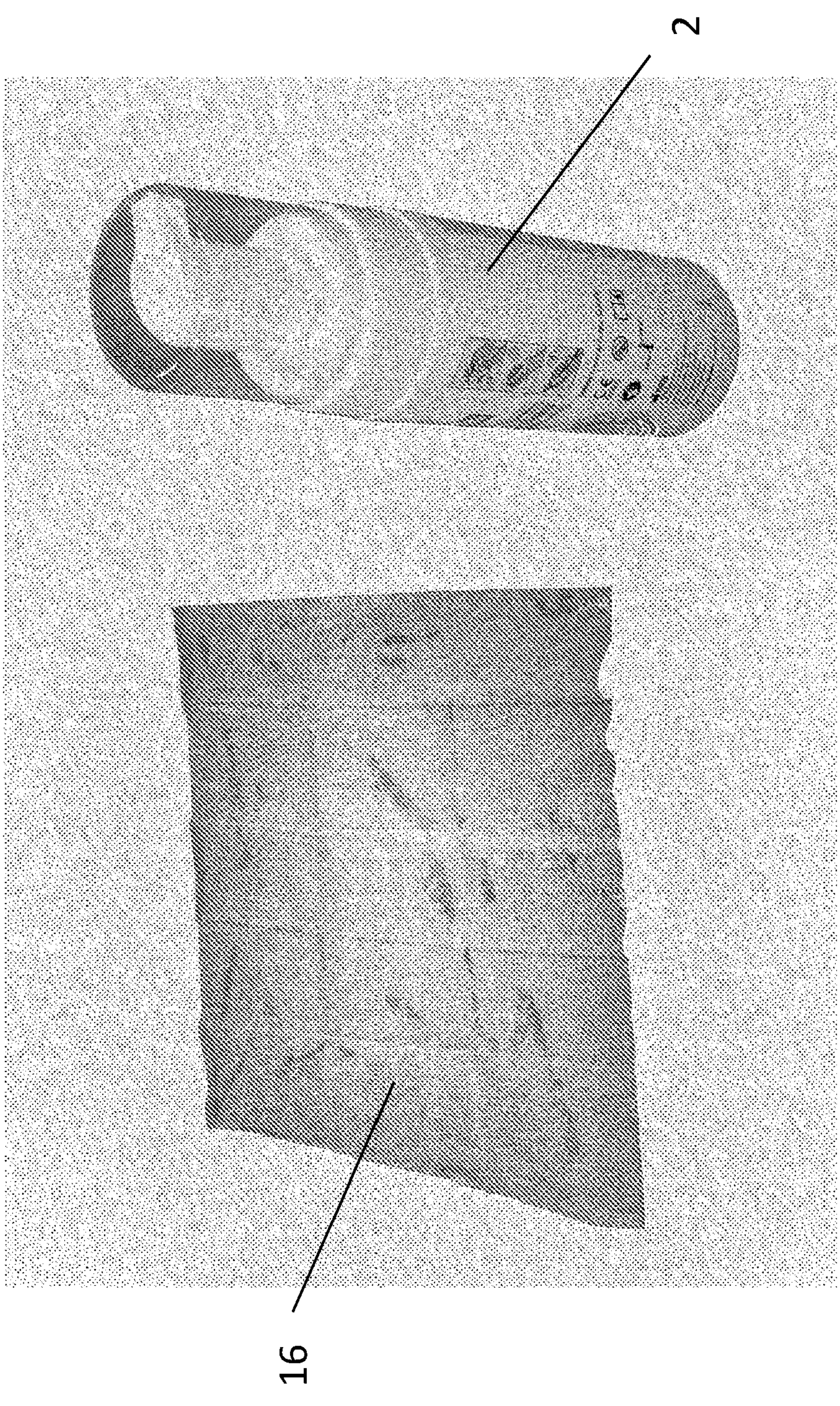


FIG. 3

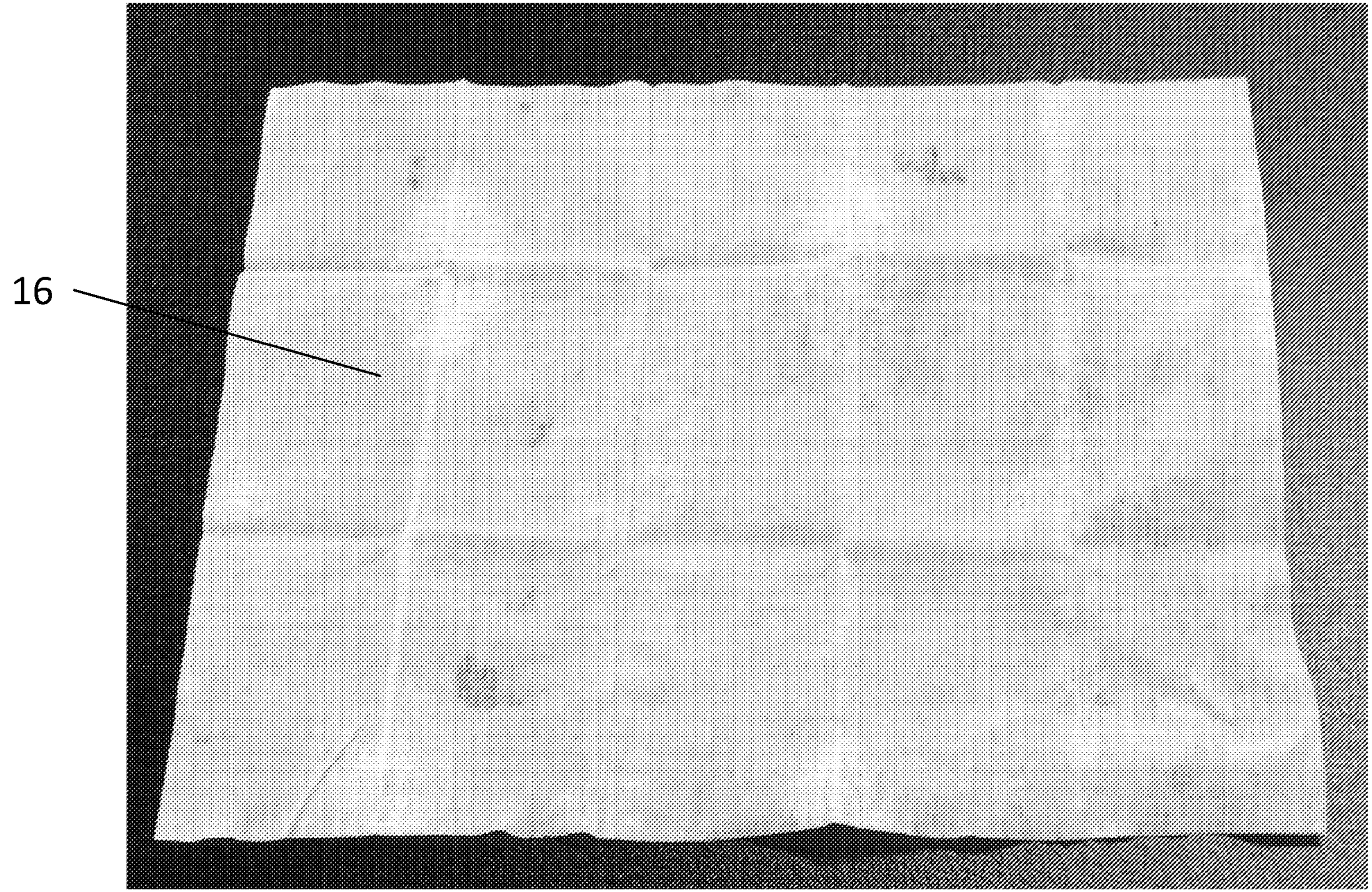
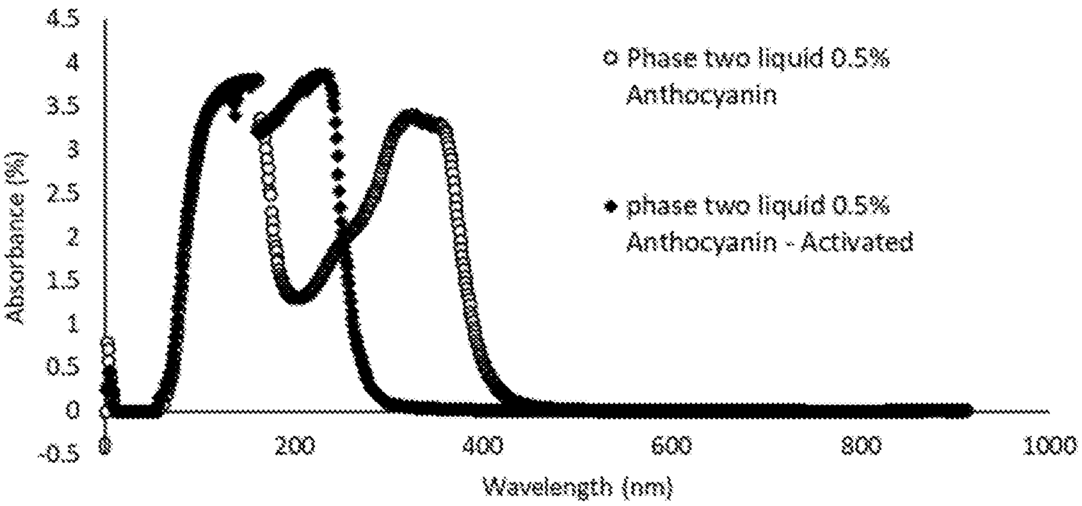


FIG. 4



4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
Absorbance (%)
0
200
400
600
800
1000
Wavelength (nm)
Phase two liquid 0.5% Anthocyanin
phase two liquid 0.5% Anthocyanin - Activated

FIG. 5

29 09 21

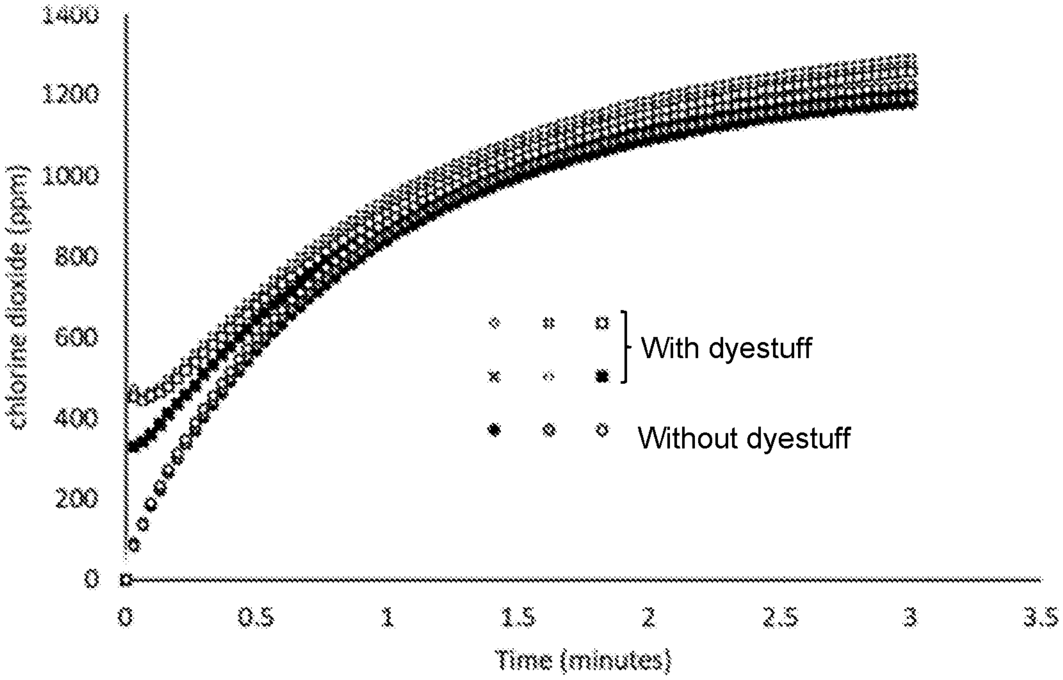

1400
1200
1000
800
600
400
200
0
chlorine dioxide (ppm)
0
0.5
1
1.5
2
2.5
3
3.5
Time (minutes)
With dyestuff
Without dyestuff

FIG. 6

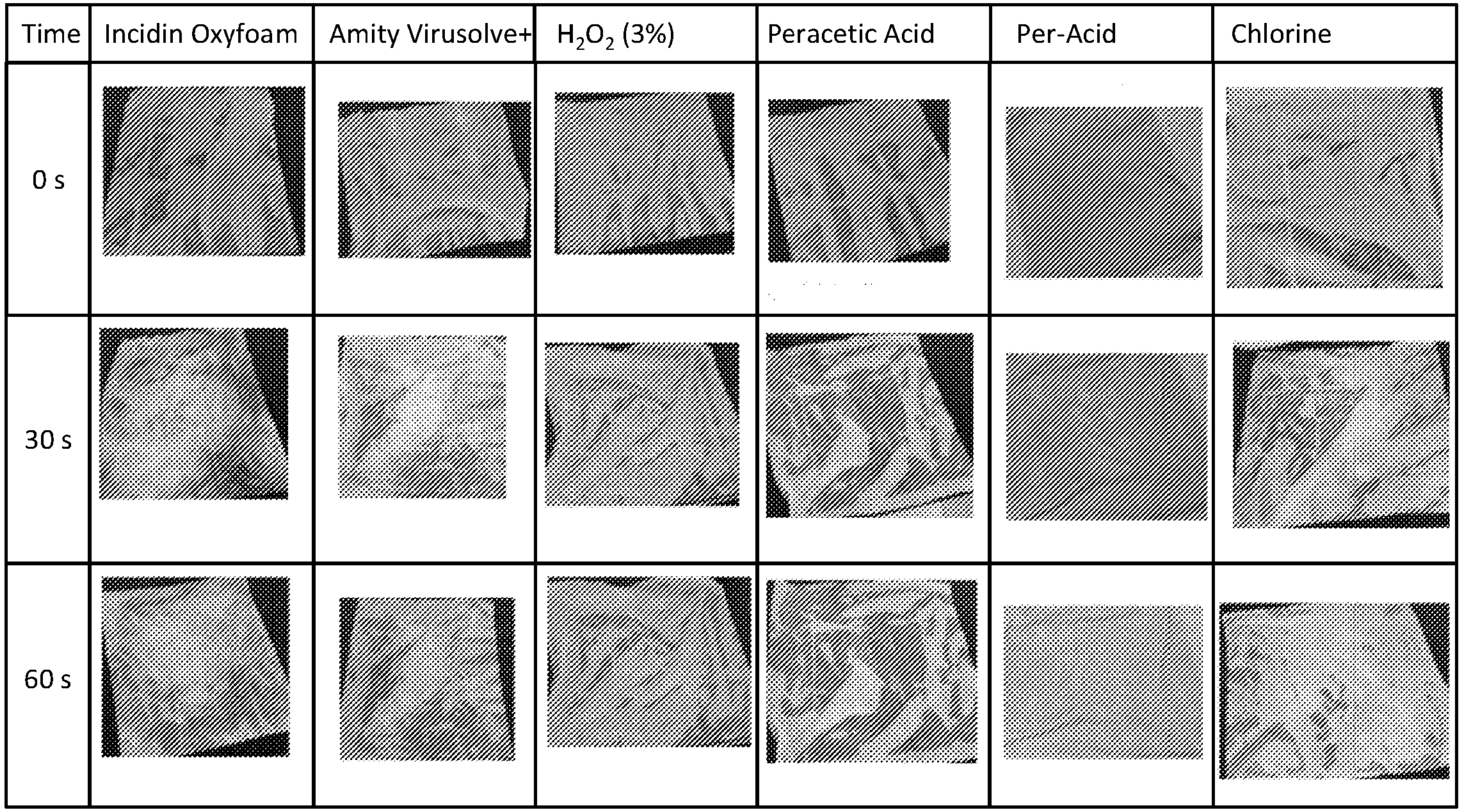

Time
Incidin Oxyfoam
Amity Virusolve+
H2O2 (3%)
Peracetic Acid
Per-Acid
Chlorine
0 s
30 s
60 s

FIG. 7

29 09 21

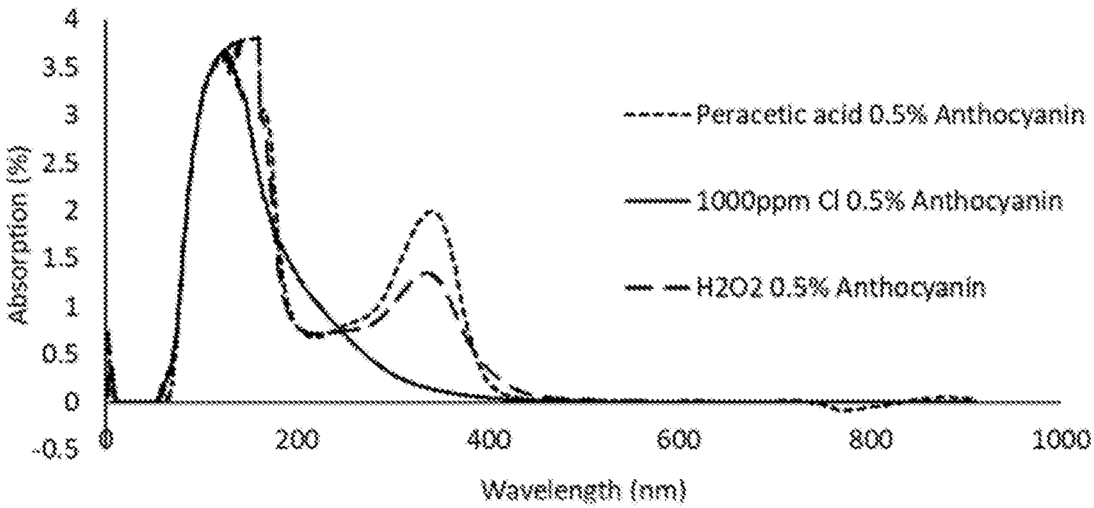

4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
Absorption (%)
0
200
400
600
800
1000
Wavelength (nm)
Peracetic acid 0.5% Anthocyanin
1000ppm Cl 0.5% Anthocyanin
H2O2 0.5% Anthocyanin

FIG. 8

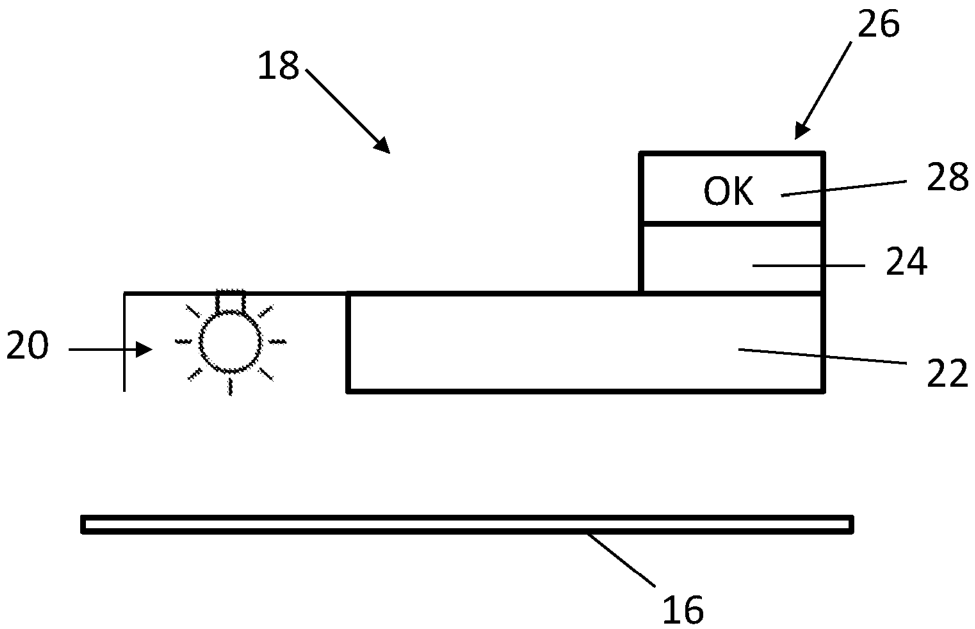


FIG. 9

DISINFECTANT SYSTEM

BACKGROUND

a. Field of the Invention

The present invention relates to a disinfectant system, notably to a system for preparing chlorine dioxide using a two-part chemistry. The invention is particularly for use in disinfecting medical devices and surfaces, notably surfaces in clinical environments, but it is not limited to these uses.

b. Related Art

Two-part disinfectant systems which produce chlorine dioxide when mixed are known. Such systems typically include a chlorite and an acid, or a chlorate, a reducing agent and an acid.

WO 2005/011756 discloses a two-part disinfecting system (shown in Figure 1). The disinfecting system 6 comprises a first part having a first reagent in a carrier medium and a second part which is miscible with the first part and which comprises a second reagent in a carrier medium. The first reagent and the second reagent react when mixed to provide a disinfecting composition. The first part is contained in a pump dispenser 2 whereby it may be dispensed as a fluid, preferably as a foam, and the second part is absorbed or impregnated in at least one fabric member in a sealed container 4. To prepare a disinfecting wipe, a user removes an impregnated wipe from the container, and applies a portion of foam from the sprayer to the wipe. To facilitate mixing of the reagents in the foam and the wipe, the user may fold the wipe in half and crush or rub the folded wipe before opening it out.

WO 2005/107823 describes a system (shown in Figure 2) suitable for the reprocessing of non-lumened medical devices using a manual three-wipe disinfection process. An example system includes a box 10 containing sachets 8 of pre-clean wipes, a disinfecting system 6 as discussed above, and a box 14 containing sachets 12 of sterile rinse wipes. The pre clean wipe is used to wipe an item such as an endoscope which is to be decontaminated. The two-part disinfecting system 6 (combination of a wipe and activator foam) is used for sterilising or disinfecting the item and the sterile rinse wipe is used to remove any chemical residue. All disinfection details can be recorded in an accompanying audit trail book to allow full procedural traceability.

To ensure full effectiveness of a disinfectant wipe, it is desirable to ensure that chlorine dioxide has been generated and that the action of generating chlorine dioxide can be verified by the end user.

It has been proposed to include in one of the components a pH-sensitive indicator which changes colour or becomes coloured when adequate mixing has occurred. A problem with this approach is that pH may not change much, or a change in pH may not reliably correlate with generation of sufficient chlorine dioxide.

As the medical industry develops there are pressures to move towards automated disinfection systems that are perceived to provide additional assurances that the disinfection process has been successfully completed. The primary arguments in favour of these systems are that they eliminate or reduce the probability of user error and can provide a digital ticket at the end of a machine cycle.

Currently available technologies include test strips, odour detection, titrations and spectrophotometry. Although all able to determine chlorine dioxide concentration they are limited by accuracy of measurement (with some methods semiquantitative), the requirement for a laboratory facility and the impingement on the natural process flow of device reprocessing.

SUMMARY OF THE INVENTION

Aspects of the invention are specified in the independent claims. Preferred features are specified in the dependent claims.

By incorporating a suitable dyestuff in one of the parts of the system, it is possible to verify, either by eye or by opto-electronic means, that chlorine dioxide has been produced at an efficacious level in the combined parts prior to use for sterilisation or disinfection. It is also possible to verify that chlorine dioxide has been produced in the whole of the medium comprising the combined parts, by checking whether the colour change has occurred spatially uniformly throughout the medium.

Suitable dyestuffs are those that oxidise in the presence of chlorine dioxide to produce a visible colour change upon mixing of the first reagent with the second reagent, but that do not exhibit the same colour change upon exposure to a disinfecting composition comprising hydrogen peroxide and/or peracetic acid. Preferably, the dyestuff also does not exhibit the same colour change upon exposure to disinfecting compositions including quaternary ammonium compounds and/or triamines.

The dyestuffs used in embodiments of the invention are therefore selective for chlorine dioxide, meaning that the colour change does not occur in the presence of other commonly-used high-level disinfectants or sterilants. In this way, the present invention provides a safeguard against incorrect use of the disinfectant system, for example in scenarios where one part of the system could be mistakenly substituted with one or more other disinfectant products.

Anthocyanin dyestuffs and anthocyanidin dyestuffs have been found to be suitable for use in the present invention. In one embodiment, the dyestuff comprises Antho Black Carrot Extract (an anthocyanin dyestuff).

Certain azo dyestuffs have also been found to be suitable for use in the present invention, including carmoisine (also known as E122), allura red (E129) and tartrazine (E102). Certain tryarylmethane dyesfuffs have also been found to be suitable, including xanthene dyestuffs, such as erythrosine (E127), and Brilliant Blue FCF (E133 or Food Blue 2 CI 42090).

The dyestuff preferably changes from coloured to colourless in the presence of chlorine dioxide. In such cases, the part of the system containing the dyestuff usually exhibits a distinctive pre-exposure colour of the dyestuff, which is observed to disappear after efficacious mixing of the two parts.

The first reagent may comprise a metal chlorite and the second reagent may comprise an acid. The dyestuff may be provided in either the first part, or the second part, or even in both parts.

The first part and the second part of the disinfectant system can each be of any form, subject to compatibility with one another. In general, the first part could for example be any one of a liquid, a foam or a powder or may be impregnated into or otherwise carried on a wipe. The second part could also for example be any one of a liquid, a foam or a powder or may be absorbed or impregnated into or otherwise carried on a wipe. The disinfecting composition may be ready to use, with no dilution required after mixing of the two parts, or may be concentrated for subsequent dilution after mixing to provide a suitable concentration for use.

In one embodiment, the first part is contained in a dispenser whereby it may be dispensed as a fluid, and the second part is absorbed or impregnated in at least one fabric wipe. In such cases, the second part may comprise the dyestuff, so that the colour change can be most readily observed when the first part is applied to the wipe.

The first part or the second part respectively may comprise between about 0.01% and about 2% dyestuff. Preferably, after mixing of the first reagent with the second reagent, substantially all of the dyestuff is oxidised by the resulting chlorine dioxide.

The present invention extends to a method of verifying the production of a disinfecting composition including chlorine dioxide using a disinfectant system as described above. The method comprises mixing the first part and the second part then, during mixing of the first part and the second part, observing said colour change, and determining that the disinfecting composition including chlorine dioxide has been produced when said colour change is complete and spatially uniform. The colour change may be observed by eye, or by a suitable opto-electrical system. A suitable machine vision system may be used to perform the observing and determining steps.

For disinfectant systems including a wipe, a method of determining whether the wipe contains chlorine dioxide comprises illuminating at least one surface region of the fabric wipe with at least one wavelength of light, determining an intensity value by measuring the intensity of the at least one wavelength of light reflected from at least one surface region of the fabric wipe, said wavelength corresponding to a wavelength absorbed by the dyestuff, comparing the intensity value with a preset threshold value, and signalling that the wipe contains sufficient chlorine dioxide if the intensity value is at or above the threshold value, or signalling that the wipe contains insufficient chlorine dioxide if the intensity value is below the threshold value. A corresponding apparatus comprises a device for measuring, from at least one surface region of a wipe, an intensity value of at least one wavelength of light corresponding to a wavelength absorbed by the dyestuff, a comparator device for comparing the intensity value with a preset threshold value, and a signalling device for signalling that a wipe contains sufficient chlorine dioxide if the intensity value is at or above the threshold value, or signalling that the wipe contains insufficient chlorine dioxide if the intensity value is below the threshold value.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be further described, by way of example only, with reference to the following drawings, in which:

Figures 1 and 2 show prior art disinfectant systems;

Figure 3 shows a disinfectant system in accordance with an embodiment of the present invention;

Figure 4 shows a fabric wipe of the system of Figure 3 after activation to produce chlorine dioxide;

Figure 5 shows absorbance measurements as a function of wavelength for an anthocyanin dyestuff in one part of a two-part disinfectant system before and after activation with the other part of the disinfectant system;

Figure 6 shows chlorine dioxide generation as a function of time for a disinfectant system including an anthocyanin dyestuff and for a disinfectant system not including a dyestuff;

Figure 7 shows comparative examples of fabric wipes treated with different disinfecting compositions;

Figure 8 and shows absorbance measurements as a function of wavelength for an anthocyanin dyestuff solution upon exposure to different disinfecting compositions; and

Figure 9 is a schematic view of apparatus in accordance with another aspect of the invention.

DETAILED DESCRIPTION

The prior art systems illustrated in Figures 1 and 2 are suitable for use in the present invention, but with the difference that, in a first embodiment, the second part further comprises an anthocyanin dyestuff.

In the present example, the first part comprises less than 1% sodium chlorite, and less than 2.5% amphoteric surfactant. The remainder is deionised water. In this specification, all parts are by weight unless otherwise indicated. Operation of the pump trigger dispenses the first part as a foam.

The wipes 16 are impregnated with an aqueous acid solution (second part). In this example, the acid solution comprises 1-5% citric acid and 1% Antho Black Carrot Extract as the anthocyanin dyestuff. The remainder is deionised water.

The anthocyanin dyestuff provides the fabric wipe 16 (Figure 3) with a characteristic colour. In this embodiment, the wipe 16 has a pinkish-red colour before the first part is added. We have found that, in the presence of chlorine dioxide, the anthocyanin dyestuff is readily oxidised to a non-coloured substance. This results in the wipe 16 losing its characteristic colour (Figure 4). The system provides a positive indication when chlorine dioxide has been generated and the action of generating the chlorine dioxide can be verified by the end user.

Use of a stable, selective dyestuff allows for the verification of not only the presence of chlorine dioxide but additionally the correct level of chlorine dioxide to ensure efficacy. The dyestuff also provides an environmental risk mitigator in the event of using the product outside of its recommended use temperature. The rationale is that the rate of chlorine dioxide generation is slower at colder temperatures and faster at higher temperatures. The rate of dye oxidation will be proportional to the level of chlorine dioxide generated.

Various dyestuffs were investigated for the ability to provide selectivity towards chlorine dioxide. In addition, the safety profile of each dye required assessment to ensure that during the oxidation process no harmful byproducts were formed which would have the potential to be detrimental to patient safety.

Potassium iodide, for example, exhibits a detectable colour change upon oxidation in the presence of chlorine dioxide, but also exhibits the same behaviour with other common oxidising disinfectants, such as hydrogen peroxide. Potassium iodide is therefore non-selective for chlorine dioxide and is not suitable for use in the present invention. Metal-based pigments are generally not suitable, as they are not readily oxidised by chlorine dioxide.

Research led to the finding that anthocyanin-based dyes are suitable for use in chlorine dioxide disinfectant systems because of ease of oxidation, selectivity and safety.

Anthocyanins, such as Antho Black Carrot Extract (AnthoCarrot), are a family of naturally derived pigments which are often responsible for the red-blue colours observed in fruits and vegetables. These compounds are readily found in food, being present in much of our produce as well as being used as natural dyes and food additives.

Anthocyanins have no reported toxicological information or warnings and are generally considered safe for use.

Anthocyanin is red when incorporated into a phase two liquid solution (i.e. the aqueous acid second part of the disinfectant system) and is oxidised to colourless when activated with a phase one foam (i.e. a foam containing the sodium chlorite-containing first part). In order to assess the degree of oxidation of anthocyanin, post activation, spectrophotometric analysis of activated (mixed) and non-activated (before mixing) phase two liquid solution with 0.5% anthocyanin (AnthoCarrot) was conducted.

Samples were activated with a 1:3 addition of phase one foam solution to phase two liquid solution and allowed to reach peak chlorine dioxide generation before testing

(2 minutes). Figure 5 shows the spectroscopic results, which shows that all anthocyanin is broken down by the generated chlorine dioxide. This can be best observed by the absence of the peak at 350nm in the activated sample versus the non-activated sample, when maintaining equal anthocyanin starting concentrations.

Several chlorine dioxide generation tests were conducted to ensure that, although oxidation of the dyestuff consumes some chlorine dioxide, overall chlorine dioxide generation is still reaching expected levels. Figure 6 shows chloride dioxide generation profiles for multiple samples of the foam-liquid system described above with and without the dyestuff. The graph of Figure 6 shows that, during the initial reaction of the dyestuff with chlorine dioxide, slight interference is observed, however after about 30 seconds curve profiles and peak levels, within experimental error, are substantially identical.

Confirmatory microbiological testing was also conducted which shows efficacy is maintained on inclusion of the selective dyestuff.

Dye selectivity testing was conducted to test whether the anthocyanin dye would react or degrade in the presence of other common use high level disinfectants and oxidisers, including hydrogen peroxide, peracetic acid, and chlorine. Tests were conducted on wipes impregnated with 9 ml of 1% AnthoCarrot base, with 3 ml of each product (equivalent to a single dose of the first part from the pump 2). The wipes were then scrunched by hand for 15 s with pictures taken at time points 0, 30 and 60s. The results are shown in Figure 7 and summarised in Table 1.

Table 1

Test product	Description	Colour change after 60s
Incidin Oxyfoam	hydrogen peroxide-based disinfectant	none
Amity Virusolve +	bis (3-aminopropyl) dodecylamine with didecyldimethyl ammonium chloride	none

H_2O_2	hydrogen peroxide 3%	none
Peracetic acid	10,000 ppm stabilised with hydrogen peroxide	none
Per-acid	10,000 ppm stabilised with hydrogen peroxide	none
Chlorine	1000 ppm	incomplete colour loss

As can be seen, only chlorine (1000 ppm) influenced the dye. No other high level disinfectant or strong oxidiser fully degraded the colour in the wipes. Chlorine successfully removed much of the dye colouration, however it was not able to fully degrade it, with some spotting remaining even at 60 s. Furthermore, the wipe itself was affected by chlorine, with it turning to an off-white colour rather than its original colour, as the wipes do when exposed to chlorine dioxide. Based on this it can be safely said that the anthocyanin dye has a high specific selectivity for chlorine dioxide and can be used as a measure of wipe activation.

In a further selectivity test, 0.5% anthocyanin (AnthoCarrot) was added to common oxidisers in liquid form and the resulting mixture spectroscopically analysed. The results are shown in Figure 7, and show that peracetic acid and hydrogen peroxide were unable to fully oxidise the dye with colour still observed. Chlorine mostly decomposed the dye, but a precipitate formed.

Various other dyes have been tested to assess suitability for use in the present invention. The requirements for a suitable dyestuff are that it is stable in at least one of the two parts of the disinfectant system, was readily oxidised in the presence of chorine dioxide and was unstable or not oxidised in other leading oxidising compounds.

Samples of dyes where tested on liquid and wipe variants of the second part of the system for stability and chlorine dioxide generated from the combination of the second part with samples of liquid and foam versions of the first part, and in addition tested against the below oxidisers/disinfectants which are commonly used:

Hydrogen peroxide (30,000ppm)
Hydrogen peroxide spray – with surfactant (commercial product – Ecolab Oxifoam)
Peracetic acid 10,000ppm
Peracetic acid/hydrogen peroxide combination (10,000ppm)
Chlorine 1,000ppm
Triamine/quaternary ammonium disinfectant (Amity Virosol +)

The following categories of dyestuffs were tested and identified as suitable for selective oxidation by chlorine dioxide and stability prior to use. None of the dyes produced an identical outcome result when used with the above disinfectants:

Anthocyanins
Anthocyanidins
Carmoisine (E122)
Allura red (E129)
Tartrazine (E102, CI 19140 FD&C Yellow)
Xanthene-based dyestuffs (E127)
Brilliant Blue FCF (E133, Food Blue 2 CI 42090)

A further benefit of the disinfectant system of the present invention is that the use of a chlorine dioxide-selective dyestuff allows for confirmation not just that chlorine dioxide has been produced, but that the correct level of chlorine dioxide has been generated. The rate at which the chosen dyestuff is oxidised is directly proportional to the rate of inclusion. It is therefore possible to tailor the inclusion rate (i.e. the amount of dyestuff added) to ensure that total removal of colour occurs once a certain chlorine dioxide level has been reached.

It is known that chlorine dioxide rate of generation is directly proportional to temperature (see, for example, Mo *et at.*, “Kinetics of the Preparation of Chlorine dioxide by Sodium Chlorite and Hydrochloric Acid at Low Concentration”, Chemical Engineering Transactions (46) 49-54 2015). Higher temperatures result in faster rates of generation. As the rate of dye oxidation is directly proportional to the rate of generation, the inclusion of a selective chlorine dioxide dye indicator allows for the mitigation of temperature on the rate of generation in use. Accordingly, regardless of the temperature at which the system is being used, it can be relied upon that until all dye colour has visibly disappeared the desired chlorine dioxide level has not been reached.

Testing was conducted to show that the inclusion of selective dyestuffs provided positive confirmation of the correct level of chlorine dioxide. Testing was conducted using 3 dyes with solutions reacted at various temperatures, as set out in Table 2. When all dye stuff was oxidised, spectrophotometry analysis confirmed that intended levels of chlorine dioxide had been generated. Analysing chlorine dioxide levels before all dye had oxidised showed sub optimal levels of chlorine dioxide. Each dye tested was used in a different chlorine dioxide formulation with a different intended final concentration to show that the verification effect was observed across multiple dye stuffs and products.

Table 2: time to total dye oxidation and desired chlorine dioxide generation (average of three replicates)

	Temperature		
Dyestuff	**4°C**	**20°C**	**60°C**
Anthocyanin	180 seconds	83 seconds	34 seconds
Food Blue 2 CI 42090 / CI 19140 FDC yellow dye	92 seconds	31 seconds	3 seconds
Xanthene dye (red)	80 seconds	38 seconds	5 seconds

These results show that various dyestuffs suitable for use in the present invention can effectively confirm the presence of a desired level of chlorine dioxide by exhibiting total oxidation, regardless of temperature. By increasing or decreasing the dye inclusion rate, the concentration of chlorine dioxide at which the dye is fully oxidised can be suitably selected.

Using a camera and appropriate software, or other suitable apparatus, it is possible to accurately determine the presence or absence of the dye pigment. This allows robust verification that active chlorine dioxide has been generated.

Referring now to Figure 9, a schematic apparatus 18 for determining whether a wipe 16 contains sufficient chlorine dioxide is illustrated. The apparatus 18 includes a lamp 20 for illuminating at least one surface region of the fabric wipe 16 with at least one wavelength of light corresponding to a wavelength absorbed by the anthocyanin dyestuff. In the present example, Antho Black Carrot Extract absorbs light in the range about 450 to about 560 nm, with a peak at about 530 nm (green). The apparatus 18 includes a device 22 for measuring the intensity of the at least one wavelength of light, and a comparator device 24 for comparing the intensity value with a preset threshold value. A signalling device 26 signals that the wipe contains sufficient chlorine dioxide if the intensity value is at or above the threshold value (indicating that the dyestuff is not absorbing the light). If the intensity value is below the threshold value, the signalling device 26 signals that the wipe 16 contains insufficient chlorine dioxide (the dyestuff is absorbing the light). In this example, the signalling device includes a display 28 that provides a visual indicator. It will be understood that other signals may be used, including sounds or coloured lights, and that signals may additionally or alternatively be logged digitally on a PC or other suitable device.

The step of determining the intensity value may comprise measuring the intensity of at least one wavelength of light reflected from a plurality of surface regions of the fabric wipe and calculating the intensity value as the mean average of each measurement. To facilitate this, the apparatus 18 may further comprise a component for calculating the intensity value as the mean average of a plurality of intensity measurements.

The apparatus may be arranged to measure the intensity of multiple wavelengths of light and/or a range of wavelengths of light. The wavelength or wavelengths selected should preferably correspond to a wavelength that is strongly absorbed by the dye before activation and that is not absorbed after activation, and preferably should avoid any interference from chlorine dioxide, which exhibits absorption at around 360nm and around 445nm. For Antho Black Carrot Extract, the selected wavelength may be in the range of between around 500 nm and around 560 nm, and is preferably around 530 nm.

The term “fluid” is used herein to include liquids, foams, sprays, pastes, aerosols, powders, sols and gels. It is particularly preferred that the first part is dispensed as a foam or a spray to facilitate its coverage of a desired area of the wipe.

While the above-described examples relate to a disinfectant system comprising a foam activator (providing the first part) and a fabric wipe (providing the second part), with the dyestuff included in the second part, this is merely one example. Table 3 describes examples of possible delivery forms for the first part, including sodium chlorite, and Table 4 describes examples of possible delivery forms for the second part, including an acid.

Table 3: First part examples

Form	**Description**
Powder	A product containing powdered sodium chlorite as the chlorine dioxide releasing agent with a strength of 5-15% (nominal 10%), and a flow agent to assist with maintaining powder properties and reducing clumping.
Liquid	A product containing liquid sodium chlorite as the chlorine dioxide releasing agent with a strength of 0.25% to 10% (0.5-4.0% nominal) and a diluent (preferably water, alternatively glycols, ethers, surfactants or any combination of these).
Foam	A product utilising a liquid formulation containing liquid sodium chlorite as the chlorine dioxide releasing agent with a strength of 0.25% to 10% (0.5-4.0% nominal), a surfactant (cationic, anionic, non-ionic, amphoteric or any ratio or combination thereof) with an inclusion rate of 0.5 – 25%, and a diluent (preferably water, alternatively glycols, ethers, surfactants or any combination of

	these) which is deployed via a foam pump apparatus.
Wipe	A substrate (synthetic, naturally derived, or any combination, with or without production-included dyes), impregnated with a solution of the above liquid formulation.

Table 4: Second part examples

Form	**Description**
Powder	A product containing powdered acid (preferably citric acid anhydrous, however can be substituted for comparable acids such, but not limited to, malic or tartaric acid) with an inclusion rate of 40-90% (nominal 60%), a dyestuff selective for chlorine dioxide, with an inclusion rate of 0.01%-5.00% (nominal 1.00%), and a free flow agent to maintain powder mobility and reduce clumping (preferably fumed silica).
Liquid	A product containing a soluble/dissolved acid (preferably citric acid monohydrate, however can be substituted for comparable acids, or combination of, such as, but not limited to, malic, tartaric, citric acid anhydrous, phosphoric, hydrochloric or sulphuric acid) with an inclusion rate of 1-30% (nominal 1-10%), a dyestuff selective for chlorine dioxide, with an inclusion rate of 0.01%-5.00% (nominal 1.00%), and a diluent (preferably water, alternatively glycols, ethers, surfactants or any combination of these).
Foam	A product containing a soluble/dissolved acid (preferably citric acid monohydrate, however can be substituted for comparable acids, or combination of, such as, but not limited to, malic, tartaric, citric acid anhydrous, phosphoric, hydrochloric or sulphuric acid) with an inclusion rate of 1-30% (nominal 1-10%), a dyestuff selective for chlorine dioxide, with an inclusion rate of 0.01%-5.00% (nominal 1.00%), a surfactant (cationic, anionic, non-ionic, amphoteric or any ratio or combination thereof) with an inclusion rate of 0.5 – 25%, and a diluent (preferably water, alternatively glycols, ethers, surfactants or any combination of these) which is deployed via a foam pump apparatus.

Wipe	A substrate (synthetic, naturally derived, or any combination of these) impregnated with a solution of the above liquid formulation. The dyestuff selective for chlorine dioxide can be incorporated, if desired, into the manufacturing process of the substrate material, so that it is in-situ prior to impregnation with liquid.

In either or both parts, additional components may be added to enhance performance or provide desired effects or behaviour. These include, for example, powdered/liquid surfactants (preferably non-ionic, but may include cationic, amphoteric and/or anionic); chelating agents with high affinity for sodium sequestration (to increase rate of sodium chlorite decomposition) and foam building; dyes; fragrances; fragrance suppressants (such as zeolites); secondary oxidisers such as sodium percarbonate; absorbent materials (including superabsorbent polymers, naturally derived clays and pumice blends etc.); and thickening agents.

Table 5 presents some possible combinations of these delivery forms. In some cases, mixing of the parts results in a concentrated disinfecting composition, which may be diluted before use. In other cases, mixing of the parts creates a ready-to-use disinfecting product. The ratio of the parts for mixing can be selected according to the composition and application, and may be between 1:3 and 3:1 or greater. In some examples, the ratio is 1:1.

Table 5: Possible delivery combinations

First part	**Second part**	**Further dilution**
Liquid	Liquid	Dependant on application
Liquid	Powder	Dependant on application
Liquid	Wipe	No
Liquid	Foam	Dependant on application
Powder	Powder	Dependant on application
Powder	Liquid	Dependant on application
Powder	Wipe	No
Powder	Foam	Dependant on application

Wipe	Liquid	Dependant on application
Wipe	Foam	No
Foam	Liquid	Dependant on application
Foam	Powder	Dependant on application
Foam	Wipe	No
Foam	Foam	Dependant on application

Further modifications and variations not explicitly described above may also be contemplated without departing from the scope of the invention as defined in the appended claims.

CLAIMS

1. A disinfectant system comprising:

(a) a first part comprising a first reagent in a carrier medium; and

(b) a second part which is miscible with the first part and which comprises a second reagent in a carrier medium;

wherein the first reagent and the second reagent will react when mixed to provide a disinfecting composition including chlorine dioxide;

characterised in that

the first part or the second part further comprises a dyestuff that oxidises in the presence of chlorine dioxide to produce a visible colour change upon mixing of the first reagent with the second reagent;

wherein said colour change does not occur upon exposure of the dyestuff-containing part to a disinfecting composition comprising hydrogen peroxide and/or peracetic acid.

2. A disinfectant system according to Claim 1, wherein the dyestuff comprises an anthocyanin dyestuff or an anthocyanidin dyestuff.

3. A disinfectant system according to Claim 2, wherein the anthocyanin dyestuff is Antho Black Carrot Extract.

4. A disinfectant system according to Claim 1, wherein the dyestuff is an azo dyestuff selected from the group consisting of: carmoisine, allura red and tartrazine.

5. A disinfectant system according to Claim 1, wherein the dyestuff is tryarylmethane dyesfuff selected from the group consisting of: xanthene dyestuffs and Brilliant Blue FCF.

6. A disinfectant system according to any of the preceding claims, wherein the dyestuff changes from coloured to colourless in the presence of chlorine dioxide.

7. A disinfectant system according to any of the preceding claims, wherein the first reagent comprises a metal chlorite and the second reagent comprises an acid.

8. A disinfectant system according to any of the preceding claims, wherein the first part is contained in a dispenser whereby it may be dispensed as a fluid, and the second part is absorbed or impregnated in at least one wipe.

9. A disinfectant system according to any of Claims 1 to 7, wherein the first part and the second part each comprise liquids.

10. A disinfectant system according to any of the preceding claims, wherein the second part comprises the dyestuff.

11. A disinfectant system according to any of the preceding claims, wherein the first part or the second part comprises between about 0.1% and about 2% dyestuff.

12. A disinfectant system according to any of the preceding claims, wherein, after mixing of the first reagent with the second reagent, substantially all of the dyestuff is oxidised by the resulting chlorine dioxide.

13. A disinfectant system according to any of the preceding claims, wherein said colour change does not occur upon exposure of the dyestuff-containing part to a quaternary ammonium compound-based disinfecting composition.

14. A disinfectant system according to any of the preceding claims, wherein said colour change does not occur upon exposure of the dyestuff-containing part to a triamine-based disinfecting composition.

15. A method of verifying the production of a disinfecting composition including chlorine dioxide using the disinfectant system of any of the preceding claims, the method comprising:

mixing the first part and the second part;

during mixing of the first part and the second part, observing said colour change; and

determining that the disinfecting composition including chlorine dioxide has been produced when said colour change is complete and spatially uniform.

16. A method of determining whether a wipe of the disinfectant system of Claim 8 or of any claim dependent on Claim 8 contains chlorine dioxide, the method comprising:

illuminating at least one surface region of the wipe with at least one wavelength of light;

determining an intensity value by measuring the intensity of the at least one wavelength of light reflected from at least one surface region of the wipe, said wavelength corresponding to a wavelength absorbed by the dyestuff;

comparing the intensity value with a preset threshold value; and

signalling that the wipe contains sufficient chlorine dioxide if the intensity value is at or above the threshold value; or

signalling that the wipe contains insufficient chlorine dioxide if the intensity value is below the threshold value.

17. A method according to Claim 16, wherein the step of determining the intensity value comprises measuring the intensity of at least one wavelength of light reflected from a plurality of surface regions of the wipe and calculating the intensity value as the mean average of each measurement.

18. Apparatus for performing the method of Claim 16 or Claim 17, comprising:

a device for measuring, from at least one surface region of a wipe, an intensity value of at least one wavelength of light corresponding to a wavelength absorbed by the dyestuff;

a comparator device for comparing the intensity value with a preset threshold value; and

a signalling device for signalling that a wipe contains sufficient chlorine dioxide if the intensity value is at or above the threshold value; or

signalling that the wipe contains insufficient chlorine dioxide if the intensity value is below the threshold value.

19. Apparatus according to Claim 18, comprising a lamp for illuminating the at least one surface region of the wipe with the at least one wavelength of light.

20. Apparatus according to Claim 18 or Claim 19, further comprising a component for calculating the intensity value as the mean average of a plurality of intensity measurements.

Intellectual Property Office

Application No:	GB2010736.3	**Examiner:**	Vanessa Luu
Claims searched:	1-15	**Date of search:**	14 January 2021

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-3, 5-7 and 9-15.	WO 02/091832 A1 (ALCIDE CORPORATION) See page 2, lines 29-35; page 4; page 6, lines 5-23 and paragraph 2; page 10, lines 1-3; and examples.
X	1-4, 6-9, 11-15	GB 2413765 A (TRISTEL COMPANY LTD) See page 15, paragraph 2; page 26; and Figure 5.
X	1,-4, 6- 9, 11-15	US 2006/0051266 A1 (TRISTEL COMPANY LTD) See page 6, paragraph 56 and Figure 5.
X	1-3, 5-7, 10-11, 13-15	JP 2016113354 A (CLEANCARE INC) See paragraphs 19-26, 40-46 and 54.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

A01N; A61L; C01B

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC

International Classification:

Subclass	**Subgroup**	**Valid From**
A61L	0002/28	01/01/2006
A01N	0025/00	01/01/2006
A01N	0059/00	01/01/2006
A61L	0002/18	01/01/2006

Intellectual Property Office

Application No:	GB2010736.3	**Examiner:**	Vanessa Luu
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Patents Act 1977
Further Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	16-20	EP 1707943 A2 (ETHICON INC) See paragraphs [0013], [0040], [0044], [0049] and [0071].
X	16-20	JP 2017044602 A (NAIGAI CHEMICAL PRODUCTS CO LTD) See paragraphs [0034-35].
X	16-20	CN 201145668 Y (XIAOPING HUANG) See EPODOC abstract.
X	16-20	CN 205580978 U (HANGZHOU BOIIDO ENV PROT TECH CO LTD) See "utility model content" and paragraphs [0031-32].
X	16-20	CN 201955298 U (GUANGDONG HUANKAI MICROBIAL SCI & TECH CO LTD) See paragraphs [0008-0009].
X	16-20	GB 2443715 A (GOODYER et al.) See WPI abstract AN. 2008-F95350.
X	16-20	EP 0274403 A2 (WHATMAN REEVE ANGEL PLC) See WPI abstract AN. 1988-191988.

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A01N	0025/00	01/01/2006
A01N	0059/00	01/01/2006
A61L	0002/18	01/01/2006
G01N	0021/01	01/01/2006
G01N	0021/25	01/01/2006
G01N	0021/78	01/01/2006