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(54) **Title**: SURFACE DISINFECTANT WITH RESIDUAL BIOCIDAL PROPERTY

(57) **Abstract**: A disinfectant formulation is provided imparting a residual biocidal property. The disinfectant formulation is used to treat a surface to impart a film having a capacity to quickly kill bacteria and other germs for at least 24 hours after deposit of the film on a treated surface. The disinfectant formulation comprises a polymer binder, wherein the polymer binder is an oxazoline homopolymer or an extended or a modified polymer based on an oxazoline homopolymer, and a biocidal compound. The disinfectant formulation further comprises a carrier. An article having the disinfectant formulation is provided as well as methods of making, using and applying the disinfectant formulation.

# SURFACE DISINFECTANT WITH RESIDUAL BIOCIDAL PROPERTY

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority from U.S. provisional patent application serial no. 62/084,917, filed on November 26, 2014, and from U.S. provisional patent application serial no. 62/127,075, filed on March 2, 2015, and from U.S. provisional patent application serial no. 62/166,403, filed on May 26, 2015, and from U.S. utility patent application serial no. 14/948962, filed on November 23, 2015, in the United States Patent and Trademark Office. The disclosures of which are incorporated herein by reference in their entireties.

## FIELD OF THE INVENTION

The present invention relates to the field of disinfectant formulations, and more specifically, to a disinfectant formulation imparting a residual biocidal property.

## BACKGROUND OF THE INVENTION

Microbes exist everywhere in the modern world. While some are beneficial to humans and the environment, others may have significant negative consequences for contaminated articles as well as the persons, animals and ecological members coming in contact with them. There are a number of industries and environments where such microbes are especially prevalent.

Healthcare

A hospital-acquired infection (HAI; alternatively a "nosocomial infection") is an infection whose development is favored by a hospital or healthcare environment. Such maladies typically are fungal or bacterial infections and can afflict the victim locally or systemically. Nosocomial infections can cause severe pneumonia as well as infections of the urinary tract, bloodstream, and other parts of the body.

Nosocomial infections have severe medical implications for patients and care providers. In the United States, data suggest that approximately 1.7 million instances of hospital-associated infections occur each year, with nearly 100,000 deaths resulting therefrom. European data and surveys indicate Gram-negative bacterial infections alone account for 8,000-10,000 deaths each year.

Several aggravating factors contribute to the high HAI rate. Hospitals, urgent care centers, nursing homes, and similar facilities focus their treatments on those with serious illnesses and injuries. As a result, these facilities house abnormally highly concentrated populations of patients with weakened immune systems.

A trio of pathogens is commonly found in healthcare settings and together account for approximately one-third of nosocomial infections: coagulase-negative *Staphylococci* (15%), *Candida* species (11%), and *Escherichia coli* (10%).

Worse, it is the more robust disease-causing pathogens that are present in such environments. The six so-called "ESKAPE pathogens" – *Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and *Enterobacter* species – possess antibiotic resistance and are implicated in nearly half of all nosocomial infections. Their resistance to one or more biocidal agents makes such infections particularly dangerous.

In particular, the broad nutritional versatility of *Pseudomonas* permits its survival in extreme environments, including survival on surfaces not intensively cleaned and sterilized. This pathogen's ubiquity in the hospital environment makes it a leading cause of Gram-negative nosocomial infections. Particularly vulnerable are immune-compromised patients (e.g. those afflicted with cystic fibrosis, cancer, or burns).

The most common means of HAIs is through direct or indirect contact transmission. Direct contact transmission involves a patient contacting either a

contaminated patient or worker. As care providers move through the healthcare institution, they come into contact with its many patients. These workers unwittingly act in a manner analogous to bees in a garden, "pollinating" rooms and wards as they care for residents.

Indirect contact transmission occurs when the patient contacts a contaminated object or surface. The healthcare environment presents an array of articles capable of passively vectoring pathogens.

Nosocomial infections further deal a serious blow to the volume, quality, and cost of healthcare provided by hospitals and other institutions. In addition to the roughly 100,000 HAI-related deaths occurring annually in the United States, an estimated two million more victims are forced to endure the physical ravages and emotional distress associated with these serious and avoidable illnesses.

Institutions have reacted by creating policies to impose more stringent cleanliness and disinfection requirements upon staff and the patient environment. These programs typically include frequent hand-washing and frequent disinfection of surfaces. Despite implementation of programs to curb nosocomial infections, infections still occur at unacceptably high rates.

Home care and Household

Household environments also face microbes. A main disadvantage associated with consumer disinfectants and sanitizers is that, while they can be effective at initially killing microbes, the surface is easily and quickly re-contaminated through contact, airborne microbes, and un-killed residual microbes before treatment. While some of the disinfectants would continue to offer some control if simply left on the surface, this would result in a greasy or tacky residue that would be easily negated by casual contact with the surface. Thus, there is a desire for a home care and household cleaner that kills microbes quickly on contact, then acts as a residual disinfectant but yet does not have this

undesirable sticky or tacky effect. Such cleaners may be useful for general purpose household cleaning, bathroom cleaning, and spray protectants.

A difference between hospital and healthcare cleaners and household products is the allowable VOC (volatile organic content). The regulations for most non-aerosol household consumer disinfectants are a maximum of 1% VOC.

Food Service

The food service industry also faces outbreaks in contamination of pathogens in the workplace and spreading disease out to consumers. Even though food manufacturers adopt vigorous hygiene plans and comply with tight government hygiene regulations, major outbreaks of microbes are still reported occasionally that causes serious illness among consumers. Disinfectants with residual activities should effectively alleviate the issue.

In summary, there remains a need for a formulation able to confer a residual biocidal activity to treated surfaces. It would be further advantageous if the formulation were combined with a surface disinfectant, to enable a single cleaning to both disinfect and impart the residual biocidal effect.

It further would be advantageous for the residual biocidal property to be durably associated with the treated surface, such that it may continue to provide microbial reduction for an extended period of time after application.

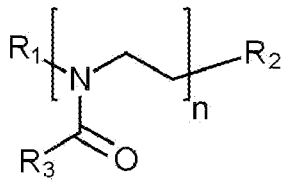
It further would be advantageous if there is a formulation(s) effective across a wide range of industries and applications.

## SUMMARY OF THE INVENTION

The present invention relates to a disinfectant formulation imparting a residual biocidal property. The disinfectant formulation comprises a polymer binder, wherein the polymer binder is an oxazoline homopolymer or an extended or a modified polymer based

on an oxazoline homopolymer, and a biocidal compound. The disinfectant formulation further comprises a carrier.

In an aspect of the invention the oxazoline homopolymer has a structure of:




wherein $R_1$ is a hydrogen, alkyl, alkenyl, alkoxy, alkylamino, alkynyl, allyl, amino, anilino, aryl, benzyl, carboxyl, carboxyalkyl, carboxyalkenyl, cyano, glycosyl, halo, hydroxyl, oxazolinium mesylate, oxazolinium tosylate, oxazolinium triflate, silyl oxazolinium, phenolic, polyalkoxy, quaternary ammonium, thiol, or thioether group; $R_2$ is a hydrogen, alkyl, alkenyl, alkoxy, alkylamino, alkynyl, allyl, amino, anilino, aryl, benzyl, carboxyl, carboxyalkyl, carboxyalkenyl, cyano, glycosyl, halo, hydroxyl, oxazolinium mesylate, oxazolinium tosylate, oxazolinium triflate, silyl oxazolinium, phenolic, polyalkoxy, quaternary ammonium, thiol, or thioether group or a macrocyclic structure; $R_3$ is a hydrogen, alkyl, alkenyl, alkoxy, aryl, benzyl, hydroxyalkyl, or perfluoroalkyl group; and n is in a range of 1 to 1,000,000.

In another aspect of the invention other features of the disinfectant formulation(s) are provided.

In yet another aspect of the invention, an article having the disinfectant formulation(s) of the present invention is provided as well as methods of making, using and applying the disinfectant formulation(s).

Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiments of the

invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following description of the embodiments of the present invention is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses. The present invention has broad potential application and utility, which is contemplated to be adaptable across a wide range of industries. The following description is provided herein solely by way of example for purposes of providing an enabling disclosure of the invention, but does not limit the scope or substance of the invention.

As used herein, the terms "microbe" or "microbial" should be interpreted to refer to any of the microscopic organisms studied by microbiologists or found in the use environment of a treated article. Such organisms include, but are not limited to, bacteria and fungi as well as other single-celled organisms such as mold, mildew and algae. Viral particles and other infectious agents are also included in the term microbe.

"Antimicrobial" further should be understood to encompass both microbicidal and microbistatic properties. That is, the term comprehends microbe killing, leading to a reduction in number of microbes, as well as a retarding effect of microbial growth, wherein numbers may remain more or less constant (but nonetheless allowing for slight increase/decrease).

For ease of discussion, this description uses the term antimicrobial to denote a broad spectrum activity (e.g. against bacteria and fungi). When speaking of efficacy against a particular microorganism or taxonomic rank, the more focused term will be used (e.g. antifungal to denote efficacy against fungal growth in particular).

Using the above example, it should be understood that efficacy against fungi does not in any way preclude the possibility that the same antimicrobial composition may demonstrate efficacy against another class of microbes.

For example, discussion of the strong bacterial efficacy demonstrated by a disclosed embodiment should not be read to exclude that embodiment from also demonstrating antifungal activity. This method of presentation should not be interpreted as limiting the scope of the invention in any way.

**Disinfectant Formulation**

The present invention is directed to a disinfectant formulation. In an aspect of the invention, the disinfectant formulation is in a liquid form. The composition of the disinfectant formulation comprises a biocidal compound and a polymer binder. The composition may further comprise a solvent (such as water or a low molecular weight alcohol), a surfactant, a colorant, a fragrance, among other components.

A liquid composition is formulated having surface disinfection and residual biocidal properties. The formulation can be applied to a surface by spraying, rolling, fogging, wiping or other means. The formulation acts as a surface disinfectant, killing infectious microbes present on the surface.

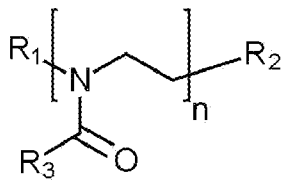
Once dried, the liquid formulation leaves a residual protective film on the surface. The residual film possesses a biocidal property, enabling it to maintain protection of the surface against microbial contamination for an extended time period after its application.

In a preferred embodiment, the surface disinfectant formulation imparts a film with the capacity to quickly kill bacteria and other germs for at least 24 hours after deposit of the film on the treated surface. In an aspect of the invention, quick kill generally refers to a time period of about 30 seconds to about 5 minutes. The film will remain on the surface and is durable to multiple touches and wearing of the surface.

The liquid composition comprises a polymer binder, a biocidal compound, a carrier such as a solvent, and other optional components such as fragrances.

Polymer Binder

In an aspect of the invention, the polymer binder is an oxazoline homopolymer. As another feature of the invention, the oxazoline homopolymer has the following structure:




wherein

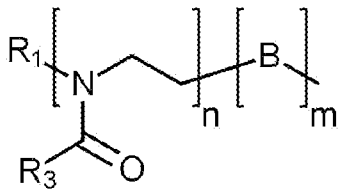
$R_1$ and $R_2$ are end groups determined by the polymerization techniques used to synthesize oxazoline homopolymer. $R_1$ and $R_2$ are independently selected and include, but are not limited to, hydrogen, alkyl, alkenyl, alkoxy, alkylamino, alkynyl, allyl, amino, anilino, aryl, benzyl, carboxyl, carboxyalkyl, carboxyalkenyl, cyano, glycosyl, halo, hydroxyl, oxazolinium mesylate, oxazolinium tosylate, oxazolinium triflate, silyl oxazolinium, phenolic, polyalkoxy, quaternary ammonium, thiol, or thioether groups. Alternatively, $R_2$ could include a macrocyclic structure formed during synthesis as a consequence of intramolecular attack.

For example, $R_1$ is a methyl group and $R_2$ is oxazolinium tosylate if methyl tosylate is used as the initiator in the cationic initiated polymerization of oxazoline.

$R_3$ is an end group determined by the type of oxazoline used in the preparation of the polymer binder of this invention. $R_3$ includes, but is not limited to, hydrogen, alkyl, alkenyl, alkoxy, aryl, benzyl, hydroxyalkyl, or perfluoroalkyl. For example, $R_3$ is an ethyl group if ethyloxazoline is the monomer used to prepare the polymer binder for the present invention.

n is the degree of oxazoline polymerization in the homopolymer. n is in a range of 1 to 1,000,000. Preferably, n is in a range of 500 to 250,000; most preferably, n is in a range of 2500 to 100,000.

Similar to oxazoline homopolymer, extended or modified polymers with some variations based on the oxazoline homopolymer are also suitable for the present invention. The techniques and options for performing chemical or molecular structure variations or modifications to oxazoline should be familiar to those skilled in the art. A class of extended or modified polymers based on oxazoline homopolymer can be represented with the following molecular structure:




wherein

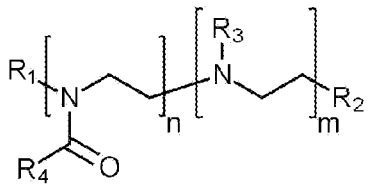
$R_1$ and $R_3$ have the same definition as those given in the above oxazoline homopolymer.

B is additional monomer repeating unit linked to oxazoline in a coploymer. The types of arrangement of the repeating units between B and oxazoline in the copolymer can include, but are not limited to, block, alternating, periodic, or combinations thereof. There is no limitation as to the types of B that can be used to copolymerize with or modify the oxazoline of the present invention.

n is the degree of polymerization for an oxazoline repeating unit; n in the copolymer is in a range of 1 to 1,000,000 and the degree of polymerization for B repeating unit in the copolymer m is in a range of 0 to 500,000 at the same time. Preferably, n is in a range of 500 to 250,000 and m is in a range of 20 to 10,000; and most preferably, n is in a range of 2500 to 100,000 and m is in a range of 50 to 5,000. In addition to linking B to

ethyloxazoline through copolymerization, B could also be linked to oxazoline as an end group in a cationic polymerization by using B as a cationic initiator if B itself is already a quaternary ammonium compound.

Not intended to be all inclusive, B can be, for example, ethyleneimine with the following molecular structure:




wherein

$R_1$ and $R_2$ end groups have the same definition as those outlined for oxazoline homopolymer.

$R_3$ includes, but is not limited to, hydrogen, alkyl, alkenyl, alkoxy, aryl, benzyl, hydroxyalkyl, or perfluoroalkyl.

$R_4$ includes, but is not limited to, hydrogen, alkyl, alkenyl, alkoxy, aryl, benzyl, hydroxyalkyl, or perfluoroalkyl.

m is in a range of 0 to 500,000; preferably, in a range of 20 to 10,000; and most preferably, in a range of 50 to 5,000.

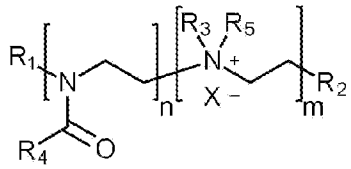
n is in a range of 1 to 1,000,000; preferably, 500 to 250,000; most preferably, in a range of 2500 to 100,000.

The synthesis of oxazoline and ethyleneimine copolymer can be phased into two steps, for example. In a first step, a cationic ring opening polymerization technique can be used to make polyoxazoline homopolymer. In a second step, the polyoxazoline made in the first step can be hydrolyzed to convert part of polyoxazoline repeating units into polyethyleneimine. Alternatively, oxazoline-ethylenimine copolymer can be made with

the appropriate respective monomers, an oxazoline and an aziridine. The result would be a cationic polymer having the above structure.

The degree of polymerization for oxazoline repeating unit n in the copolymer is in a range of 1 to 1,000,000 and the degree of polymerization for ethyleneimine repeating unit in the copolymer m is in a range of 0 to 500,000 at the same time. Preferably, n is in a range of 500 to 250,000 and m is in a range of 20 to 10,000, and most preferably n is in a range of 2500 to 100,000 and m is in a range of 50 to 5,000.

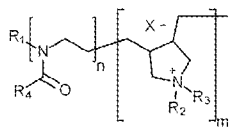
Alternatively, the nitrogen in the ethyleneimine repeating unit could be further quarternized to generate the following cationic copolymer:




Any quaternization technique that is familiar to those skilled in the art could be used to quaternize the polymer of this example. $R_1$, $R_2$, $R_3$ and $R_4$ have the same meaning as those designated in the above oxazoline-ethyleneimine copolymer. $R_5$ includes, but is not limited to, a hydrogen, methyl, ethyl, propyl, or other types of alkyl group. The corresponding anion $X^-$ is a halogen, sulfonate, sulfate, phosphonate, phosphate, carbonate/bicarbonate, hydroxy, or carboxylate.

The ranges for n and m are also the same as those described in oxazoline-ethyleneimine copolymer.

Another example of B that can be used for the present invention is polydiallyldimethylammonium chloride. Polyethyloxazoline modified with polydiallyldimethylammonium chloride has the following structure:



wherein

$R_1$ and $R_4$ have the same meaning as described in previous example for quarternized oxazoline-ethyleneimine copolymer.

$R_2$ and $R_3$, independently, include, but are not limited to, short chain alkyl groups such as $C_1$ to $C_6$. The corresponding anion $X^-$ is a halogen, sulfonate, sulfate, phosphonate, phosphate, carbonate/bicarbonate, hydroxy, or carboxylate.

n and m are defined and numbered the same as in previous examples.

B could be other olefins including, but not limited to, diallyldimethylammonium chloride, styrene, methoxystyrene, and methoxyethene. Ethyloxazoline can also be copolymerized with heterocyclic monomers such as oxirane, thietane, 1,3-dioxepane, oxetan-2-one, and tetrahydrofuran to enhance the performance of the polymer for the present invention. The binder used in this invention could also employ pendant oxazoline groups on a polymer backbone, such as an acrylic or styrene based polymer, or a copolymer containing acrylic or styrene.

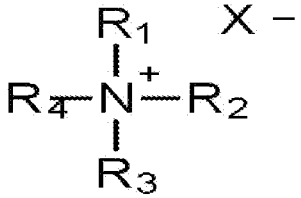
Examples of commercially available polyethyloxazolines include, but are not limited to, Aquazol 500 from Polymer Chemistry Innovations, Inc.

The amount of polymer binder that can be used in the liquid formulation can vary somewhat depending upon desired length of residual activity of the composition and the nature of all the other components in the composition. Preferably, the amount of polymer binder in the liquid formulation is in a range of 0.1% to 20% based on the weight of liquid formulation. In a liquid formulation for healthcare applications, the amount of polymer binder in the liquid formulation is more preferably in a range of 0.5% to 10%, and most preferably in a range of 0.8% to 5%. In liquid formulations for all-purpose and bathroom cleaners, the amount of polymer binder in the liquid formulation is more preferably in a range of 0.1% to 10%, and most preferably in a range of 0.1% to 5%.

The polymer binder preferably is water-soluble and can be readily removed from surface if any buildup is noticed. Present in small amounts, it nonetheless can provide a durable bond between biocidal compound and the treated surface to facilitate residual efficacy.

Biocidal Compound

The biocidal compound may be a quaternary ammonium compound (QAC) with the following molecular structure:



wherein

$R_1$, $R_2$, $R_3$, and $R_4$ are independently selected and include, but are not limited to, alkyl, alkoxy, or aryl, either with or without heteroatoms, or saturated or non-saturated. Some or all of the functional groups may be the same.

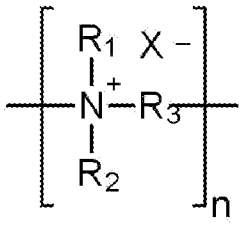
The corresponding anion $X^-$ includes, but is not limited to, a halogen, sulfonate, sulfate, phosphonate, phosphate, carbonate/bicarbonate, hydroxy, or carboxylate.

QACs include, but are not limited to, n-alkyl dimethyl benzyl ammonium chloride, di-n-octyl dimethyl ammonium chloride, dodecyl dimethyl ammonium chloride, n-alkyl dimethyl benzyl ammonium saccharinate, and 3-(trimethoxysilyl) propyldimethyloctadecyl ammonium chloride.

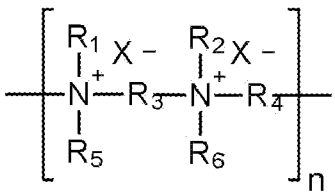
Combinations of monomeric QACs are preferred to be used for the invention. A specific example of QAC combination is N-alkyl dimethyl benzyl ammonium chloride (40%); N-octyl decyl dimethyl ammonium chloride (30%); di-n-decyl dimethyl ammonium chloride (15%); and di-n-dioctyl dimethyl ammonium chloride (15%). The

percentage is the weight percentage of individual QAC based on the total weight of blended QACs composition.

Polymeric version of the QACs with the following structures can also be used for the invention.



or



wherein

$R_1$, $R_2$, $R_5$, and $R_6$, independently, include, but are not limited to, hydrogen, methyl, ethyl, propyl or other longer carbon alkyl groups.

$R_3$ and $R_4$ are independently selected and include, but are not limited to, methylene, ethylene, propylene or other longer alkylene linking groups.

n is the degree of polymerization; n is an integer in a range of from 2 to 10,000.

Examples of cationic polymers with the above structure, include but are not limited to, polyamines derived from dimethylamine and epichlorohydrin such as Superfloc C-572 commercially available from Kemira Chemicals.

Still another polymeric QAC suitable for the invention is poly diallyldimethylammonium chloride or polyDADMAC.

Yet another class of QACs useful for the present invention are those chemical compounds with biguanide moiety in the molecule. Examples of this class of cationic antimicrobials include, but are not limited to, PHMB and chlorhexidine.

Examples of commercially available quaternary ammonium compounds include, but are not limited to, Bardac 205M and 208M from Lonza, and BTC885 from Stepan Company.

The biocidal compound may be a weak acid, which has been shown to be particularly effective in bathroom cleaners. In these type of products, citric, sulfamic (also known as amidosulfonic acid, amidosulfuric acid, aminosulfonic acid, and sulfamidic acid), glycolic, lactic, lauric and capric acids are useful as both an effective biocide and a cleaning agent for soap scum and hard wart deposits.

Other compounds which may be useful are silane quaternary salts such as 3(trihydroxysilyl)propyldimethyloctadecyl ammonium chloride. These may have the added benefit of reacting to the surface being treated for an enhancement of the residual properties.

Further biocidal compounds suitable for use in the present liquid formulation span a broad range of antimicrobials, biocides, sanitizers, and disinfectants. A water soluble or dispersible biocidal compound is preferred, although biocides soluble in alcohol may be alternatively employed.

A non-exhaustive list of biocidal compounds suitable for use in the present formulation include triclosan, zinc pyrithione, metal salts and oxides, phenols, botanicals, halogens, peroxides, heterocyclic antimicrobials, aldehydes, and alcohols.

The concentration of biocidal compound in the formulation can be in a range of 0.05% to 20% based on the weight of the liquid composition. For a liquid formulation for a healthcare application, preferably in a range of 0.1% to 20%, and more preferably in a range of 0.5% to 3%. For a liquid formulation for all-purpose and bathroom cleaners, preferably in a range of 0.05% to 10%. For a formulation for a protectant, preferably in a range of 0.05% to 2%.

Carrier

The carrier or media for the liquid formulation of this invention can be any solvent that is volatile and allow easy evaporation at ambient condition. Examples of liquid carriers include, but are not limited to, water and low molecular weight alcohols such as C1 to C8 alkanols. Specific examples include, but are not limited to, ethanol, isopropyl alcohol, butanol, pentanol, and combinations thereof.

Another class of solvents for use in the invention includes alkylene glycol ether. Examples include, but are not limited to, ethylene glycol monopropyl ether, ethylene glycol monobutyl ether, ethylene glycol monohexyl ether, ethylene clycol monohexyl ether, diethylene glycol monomethyl ether, diethylene glycol monoethyl ether, diethylene glycol monobutyl ether, diethylene glycol monohexyl ether, triethylene glycol monomethyl ether, triethylene glycol monoethyl ether, triethylene glycol monobutyl ether, propylene glycol methyl ether, propylene glycol methyl ether acetate, propylene glycol n-butyl ether, dipropylene glycol n-butyl ether, dipropylene glycol methyl ether, dipropylene glycol methyl ether acetate, propylene glycol n-propyl ether, dipropylene glycol n-propyl ether, and tripropylene glycol methyl ether.

Another class of solvents for use in the invention is based on terpenes and their derivatives such as terpene alcohols, terpene esters, terpene ethers, or terpene aldehydes. Examples of solvents, include but are not limited to, pine oil, lemon oil, limonene, pinene, cymene, myrcene, fenchone, borneol, nopol, cineole, ionone and the like.

A preferred carrier in a liquid formulation for a home care cleaning application is water.

If the method of the application of the liquid formulation of the present invention is pressurized aerosol, a propellant may be needed in the composition. A variety of propellants or mixtures can be used for the present invention and should be familiar to

those skilled in the art. C1 to C10 hydrocarbons or halogenated hydrocarbons are typical propellants in aerosol compositions known to the industry. Examples of such propellants include, but are not limited to, pentane, butane, propane, and methane. Other types of propellants that can be used for the present invention also include compressed air, nitrogen, or carbon dioxide. Alternatively, a bag on valve package may be used to aerosol the product without directly add a propellant to the composition.

Either a single solvent or a mixture of the above solvents can be used for the present invention. The types of solvents used for the present invention may depend upon the intended uses of the residual disinfectant composition. For example, if the composition of the present invent is intended for home care use, cleaning the contaminated surfaces free of all types of dirt or soil may be of primary interest. Liquid carrier or media that assist and enhance the removal of soil may be formulation of the invention. For example, the residual disinfectant formulation or composition of the present invention may desire to include alkyl or multi-alkyl glycol ethers for better cleaning performance in the home care version of the formulation of the present invention. On the other hand, if the primary goal of the residual disinfectant composition is to be used at a health care facility where the major concern is hospital acquired infection, then quick drying of the liquid composition of the present invention may be more desirable than cleaning dirt or soil out of the surfaces. Low molecular weight alcohols should be considered to help the liquid formulation of the present invent dry fast after the application. Also, a low molecular weight alcohol in the liquid formulation will strengthen the sanitizing activity of the liquid composition.

For health care use of the residual disinfectant, a mixture of water and low molecular weight alcohol is preferred. The amount of alcohol present in the liquid formulation is preferred to be at such a level that the liquid formulation is capable of

forming a zerotropic mixture between the alcohol and water. A minimum amount of alcohol, if present, in the liquid composition is 10%. Preferably, for health care use of the residual disinfectant, the alcohol concentration is 30%, and most preferably the alcohol concentration is at least 50% based on the weight of liquid formulation for the health care use of the composition of the invention.

Surfactant

A surfactant or wetting agent may be employed. The surfactant assists the liquid formulation to spread and evenly coat the surface being treated. The surfactant additionally contributes to the formation of a zeotropic mixture between alcohol and water, thus facilitating a rapid and uniform drying of the liquid formulation once being applied onto surface. A surfactant also plays an important role in the residual disinfectant liquid formulation of the present invention for home care use if the soil cleaning performance is the key feature the product is designed to possess.

Surfactants appropriate for the present liquid formulation include, but are not limited to, those that are nonionic, anionic, or amphoteric in nature. Examples of commercially available wetting agents include, but are not limited to, Ecosurf SA-4 or Tergitol TMN-3 from Dow Chemical, and Q2-5211 from Dow Corning.

An amine oxide surfactant is preferred especially when the QAC is used as the biocidal compound in the formulation.

In the category of nonionic surfactants, ethoxylated alcohols with different amounts of ethylene oxides or HLB values can be used. Examples of ethoxylated alcohols include, but are not limited to, Triton X-100 (Dow Chemical, Midland MI), Ecosurf EH nonionic surfactant series from Dow Chemical, Tergitol nonionic surfactant series from Dow Chemical, the Surfonic surfactant series from Huntsman Corp., the Neodol surfactant

series from Shell, the Ethox surfactant series from Ethox Chemicals and the Tomadol surfactant series from Air Products and Chemicals, Inc.

Another class of nonionic surfactants include alkylpolyglucosides. Examples include the Glucopon Series from BASF and the Ecoteric series from Huntsman.

An alternative class of surfactants that is preferred for the liquid formulation are silane-based surfactants. Examples include but, are not limited to, silicone polyethers organofunctional or reactive silane wetting agents, and fluorochemical based wetting agents.

The content of the surfactant in the liquid formulation is in a range of 0% to 10%, preferably in a range of 0.01% to 5%.

Depending on the targeted uses, a liquid formulation of the present invention for home care use may need appropriate pH condition. For example, if the liquid product is used in the kitchen area, a high pH product may be desired in order to effectively remove grease soils commonly found in the area. If the product is used in bathroom area, soap scum and hard water deposits may be the primary concern. In such case, a low pH product may be more appropriate for such a purpose. There is no limitation on the types of pH adjusting agents that can be added into the liquid composition of the present invention. Example of pH adjusting agents that can be used include, but are not limited to, triethanolamine, diethanolamine, monoethanolamine, sodium hydroxide, sodium carbonate, potassium hydroxide, potassium carbonate, calcium carbonate, citric acid, acetic acid, hydrochloric acid, sulfamic acid, sulfuric acid and the like.

Other than components mentioned above, additional functional components may be included in the liquid composition of the present invention. Additional components include, but are not limited to, chelants, compatibilizers, coupling agents, corrosion

inhibitors, rheology modifiers, fragrances, colorants, preservatives, UV stabilizers, optical brighteners, and active ingredient indicators.

In an embodiment of the present invention, the liquid solution comprises a polymer binder, a quaternary ammonium compound, a silicone-based surfactant, and ethanol. The liquid formulation can be made or mixed by any conventional method known to one of ordinary skill in the art. There are no preferred addition procedures for the formulation of the present invention provided that the formulation is ultimately homogeneous, compatible and stable. For example, if the polymer binder is a solid, it may be preferable to first dissolve or disperse the polymer in a carrier such as water or alcohol to make a stock polymer binder liquid dispersion. The stock polymer binder liquid dispersion may be readily added into the formulation of the present invention during the mixing procedure.

**Application of Liquid Formulation**

The liquid formulation may be applied by a variety of means. If sprayed, the liquid formulation advantageously may be supplied in a conventional bottle with a sprayer. The sprayer can be a trigger sprayer. As an option to a trigger sprayer, an aerosol can also be used to deliver the liquid formulation on to surfaces. Additional application means include, but are not limited to, fogging, rolling, brushing, mopping, and using a wipe by a variety of application devices. It is within the scope of the present invention that wipe products can also be made comprising or pre-treated with the disinfectant formulation(s) of the present invention, for example, for off-the-shelf sale or use.

To disinfect a contaminated surface, spray the liquid formulation until the area is completely covered. The wet formulation subsequently may be wiped dry with a dry cloth or paper towel.

The invention also relates to an article treated with a disinfectant formulation in accordance with aspects of the invention.

Examples

The following examples illustrate liquid formulations made in accordance with aspects of the present invention. The testing results on these formulations demonstrate the desired residual sanitizing or disinfecting performance once being applied onto surfaces and dried. Cleaning performance is also tested on those formulations that not only provide residual disinfecting benefit but also cleaning features.

Formulations were tested for residual efficacy using the EPA 01-1A protocol. Briefly, bacteria were added to a glass slide and allowed to dry on the surface. The formulation was then sprayed onto the surface and dried to form a transparent film. Once a film had formed, the glass slide was exposed to alternating wet and dry cycles using the Gardner wear tester as described in the protocol. In between each cycle the slide was re-inoculated with bacteria. After the appropriate number of wear and re-inoculations (48 passes and 11 re-inoculations for healthcare formulation and 24 passes 5 re-inoculation for homecare formulation) the slide was exposed to bacteria for the indicated time frame (i.e. 5 minutes) followed by recovery in an appropriate neutralizing solution.

In addition to residual efficacy, initial efficacy of the composition of the present invention was also tested according to ASTM E 1153.

A modified ASTM D4488 was used to evaluate the hard surface cleaning performance for the home care composition of the present invention. A soil of the following composition was used for the evaluation.

Table 1

| **Components** | **Weight percentage of each component (%)** |
|---|---|
| Pure vegetable oil | 75 |
| TM-122 AATCC carpet soil | 25 |

*TM-122 AATCC carpet soil was obtained from Textile Innovators

In the process of making a soiled ceramic tile for the cleaning test, around 2 grams of the liquid soil was placed on an aluminum foil. A roller was used to roll and spread out the soil on the foil and let the roller pick up the soil as much as possible. The soil on the roller was transferred to the glazed surface of a ceramic tile evenly by rolling the soiled roll on the ceramic surface. The soiled ceramic tile was then baked in oven set at 180C for 45 minutes. The baked tile was conditioned at room temperature for 24 hours before being used for the cleaning test.

A Gardner wear tester was used in the cleaning test. Scouring pads of around 1 cm width were attached to the abrasion boat for the wearing. Around 4 grams of test formulation was placed in a weighing boat. The attached scouring pad was dipped into the weighing boat to pick up the testing formulation.

The cleaning process started immediately after the pad is wetted with the cleaning formulation. Seven wearing cycles (back and forth) were used in the test.

**Residual disinfectant examples for healthcare**

The following formulation in the example uses alcohol as the major carrier in order to provide fast drying property to the liquid formulations.

Table 2

| Components | HE1 (wt %) | HE2 (wt %) | HE3 (wt%) |
|---|---|---|---|
| Water | balance | balance | balance |
| Ethanol | 70 | 70 | 0 |
| 2-Propanol | 0 | 0 | 70 |
| Polyethyloxazoline | 2 | 2 | 2 |
| Quaternary ammonium compound | 0.8 | 1.2 | 1.2 |
| Wetting agent/Surfactant | 0.1 | 0.1 | 0.1 |

The residual efficacy testing was conducted using EP01-1A protocol and the results are listed in the following Table.

Table 3

| **Formulation** | **EP01-1A (average log reduction bacterial)** |
|---|---|
| HE1 | 3.53 |
| HE2 | 5.50 |
| HE3 | 4.50 |

These formulations show excellent residual efficacy result based on EP01-1A test.

The ASTM E 1153 test protocol was also followed to assess the initial biocidal property of HE2. Test results are presented in the following table.

Table 4

| **Initial Efficacy** | **Time** | **Method** | |
|---|---|---|---|
| **Bacterial** | **3 log reduction** | **Complete kill (<10 CFU/PFU)** | |
| *Klebsiella pneumoniae* | 30 seconds | 1 minute | ASTM E 1153 |
| *Pseudomonas aerugniosa* | 30 seconds | 30 seconds | ASTM E 1153 |
| *Staphylococcus aureus* | 30 seconds | 30 seconds | ASTM E 1153 |
| *MRSA* | 30 seconds | 30 seconds | ASTM E 1153 |
| *VRE* | 30 seconds | 30 seconds | ASTM E 1153 |
| *Enterobacter aerogenes* | 30 seconds | 30 seconds | ASTM E 1153 |
| *Enterococcus faecalis* | 30 seconds | 1 minute | ASTM E 1153 |
| **Fungal** | | | |
| *Aspergillus niger* | 1 minute | 5 minutes | ASTM E 1153 |
| *Tricophyton mentagrophytes* | 1 minute | 5 minutes | ASTM E 1153 |
| **Viral** | | | |
| H1N1 (envelope) | 30 seconds | 30 seconds | ASTM E 1053 |
| MS2 (Non-enveloped) | 30 seconds | 5 minutes | ASTM E 1053 |
| | | | |
| **Residual Efficacy** | **Time frame of exposure** | **Log reduction** | **Method** |
| *Pseudomonas aerugniosa* | 5 minutes | >3 | EPA 01-1A |
| *Enterobacter aerogenes* | 5 minutes | >3 | EPA 01-1A |

| | | | |
|---|---|---|---|
| *Staphylococcus aureus* | 5 minutes | >3 | EPA 01-1A |

These data clearly demonstrate that sample surfaces treated with the exemplary liquid formulation disclosed herein possess a demonstrable biocidal activity at the indicated time frame.

**Residual disinfectant cleaner examples for homecare**

These compositions are formulated using water as the carrier. They are intended for homecare use where VOC regulations prohibit most use of high levels of organic solvents such as alcohols.

Table 5

| **Components** | **H1 (wt%)** | **H2 (wt%)** | **H3 (wt%)** | **H4 (wt%)** | **H5 (wt%)** |
|---|---|---|---|---|---|
| Water | balance | balance | balance | balance | balance |
| EDTA tetra sodium | 0 | 0 | 0 | 0 | 0.4 |
| Polyethyloxazoline | 1 | 1 | 1 | 0.5 | 0.5 |
| Ethoxylated alcohol #1 | 0.33 | 0 | 0 | 0 | 0 |
| Ethoxylated alcohol #2 | 0 | 0 | 0.2 | 0.2 | 0.2 |
| Quaternary ammonium compound | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Ethanolamine | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Wetting Agent | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |

The residual efficacy of these formulations were assessed using EP01-1A protocol and the results are listed in the following Table.

Table 6

| **Formulation** | **EP01-1A (average log reduction bacterial)** |
|---|---|
| H1 | 3.53 |
| H2 | 5.50 |
| H3 | 5.50 |
| H4 | 4.90 |
| H5 | 3.80 |

Enterobacter aerogenes was the bacterial for H1 testing and Staphylococcus aureus was the bacteria used in the testing for the rest of the formulations.

The testing results demonstrate that the H1 to H5 all provide residual efficacy to the treated surfaces. The cleaning performance was also evaluated using the modified ASTM D4488 test method.

The testing results also clearly visually showed the formulation of present invention not only provided residual efficacy against bacterial but also good cleaning performance on soiled surfaces.

Additional formulations set forth in the Tables below were tested for home care and home cleaning applications. To solubilize the fragrance, a pre-mix is prepared containing the fragrance, quaternary ammonium compound, surfactant and glycol ether if present.

Table 7 - Light Duty Protectant Formulations

| Component | P1 (wt %) | P2 (wt %) | P3 (wt %) | P4 (wt %) | P5 (wt %) | P6 (wt %) | P7 (wt %) | P8 (wt %) | P9 (wt %) | P10 (wt %) | P11 (wt %) | P12 (wt %) | P13 (wt %) | P14 (wt %) | P15 (wt %) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Polyethyl-oxazoline | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.50 | 1.00 | 0.50 | 1.00 | 0.50 |
| Quaternary ammonium compound | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.20 | 0.20 | 0.10 | 0.10 |
| Fragrance | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Wetting agent | 0.30 | | | | | | | | | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Amine Oxide | | 0.30 | | | | 0.30 | 0.30 | 0.30 | 0.30 | | | | | | |
| Ethoxylated Cationic surfactant | | | 0.30 | | | | | | | | | | | | |
| Dicoco quat | | | | 0.30 | | | | | | | | | | | |
| Ethoxylated alcohol | | | | | 0.30 | | | | | | | | | | |
| Tri-ethanolamine | | | | | | 0.50 | | | | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| NaEDTA | | | | | | | 0.10 | | | | | | | | |
| Sodium metasilicate pentahydrate | | | | | | | | 0.10 | | | | | | | |
| Sodium Carbonate | | | | | | | | | 0.10 | | | | | | |
| Water* | B | B | B | B | B | B | B | B | B | B | B | B | B | B | B |

| Component | P16 (wt %) | P17 (wt %) | P18 (wt %) | P19 (wt %) | P20 (wt %) | P21 (wt %) | P22 (wt %) | P23 (wt %) | P24 (wt %) | P25 (wt %) | P26 (wt %) | P27 (wt %) | P28 (wt %) | P29 (wt %) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Polyethyl-oxazoline | 1.00 | 0.50 | 1.00 | 0.50 | 1.00 | 0.50 | 1.00 | 0.50 | 1.00 | 1.00 | 1.00 | 0.50 | 0.50 | 0.50 |
| Quaternary ammonium compound | 0.20 | 0.20 | 0.10 | 0.10 | 0.20 | 0.20 | 0.10 | 0.10 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fragrance | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Wetting agent | | | | | | | | | | | | | | |
| Amine Oxide | 0.30 | 0.30 | 0.30 | 0.30 | | | | | | | | | | |
| Ethoxylated Cationic surfactant | | | | | | | | | | | | | | |
| Dicoco quat | | | | | | | | | | | | | | |
| Ethoxylated alcohol | | | | | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Tri-ethanolamine | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | | | | | | |
| NaEDTA | | | | | | | | | 0.10 | | | 0.10 | | |
| Sodium metasilicate pentahydrate | | | | | | | | | | 0.10 | | | 0.10 | |
| Sodium Carbonate | | | | | | | | | | | 0.10 | | | 0.10 |
| Water* | B | B | B | B | B | B | B | B | B | B | B | B | B | B |

*B means balance water

Table 8 - All Purpose Cleaner Formulations

| **Component** | **A1** (wt %) | **A2** (wt %) | **A3** (wt %) | **A4** (wt %) | **A5** (wt %) | **A6** (wt %) | **A7** (wt %) | **A8** (wt %) | **A9** (wt %) | **A10** (wt %) | **A11** (wt %) | **A12** (wt %) | **A13** (wt %) | **A14** (wt %) | **A15** (wt %) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Polyethyl-oxazoline | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.20 | 1.00 | 1.20 | 1.00 |
| Quaternary ammonium compound | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.50 | 0.50 | 0.40 | 0.80 | 0.40 |
| Fragrance | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Amine Oxide | | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.60 | 0.45 | 0.45 | 0.60 | 0.60 | 0.60 | 0.45 |
| Ethoxylated Alcohol 1 | 0.50 | | | | | | | | | | | | | | |
| Ethoxylated Alcohol 2 | | | | | | | | | | | | | | | |
| Alkyl-polyglucoside | | | | | | | | | | | | | | | |
| Tri-ethanolamine | | | | | | | | 1.0 | | | | | | | |
| Glycol Ether 1 | | | | | | | | | | | | | | | 5.00 |
| Glycol Ether 2 | | | | | | | | | | | | | | | |
| NaEDTA | | | 0.40 | | | | | | | | | | | | |
| Sodium metasilicate pentahydrate | | | | 0.10 | | | | | 0.25 | 0.25 | 0.25 | 0.10 | 0.10 | 0.10 | 0.10 |
| Sodium Carbonate | | | | | 0.10 | | | | | | | | | | |
| STPP | | | | | | 0.10 | | | | | | | | | |
| TKPP | | | | | | | 0.10 | | | | | | | | |
| Water* | B | B | B | B | B | B | B | B | B | B | B | B | B | B | B |

5

| **Component** | **A16** (wt %) | **A17** (wt %) | **A18** (wt %) | **A19** (wt %) | **A20** (wt %) | **A21** (wt %) | **A22** (wt %) | **A23** (wt %) | **A24** (wt %) | **A25** (wt %) | **A26** (wt %) | **A27** (wt %) | **A28** (wt %) | **A29** (wt %) | **A30** (wt %) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Polyethyl-oxazoline | 1.0 | 0.80 | 0.80 | 1.0 | 1.00 | 1.20 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Quaternary ammonium compound | 0.80 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| Fragrance | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Amine Oxide | 0.60 | 0.60 | 0.60 | 1.50 | 1.20 | 0.60 | | | | | | | | | 0.60 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ethoxylated Alcohol 1 | | | | | | | | 0.10 | | 0.20 | | | 0.60 | 0.60 | |
| Ethoxylated Alcohol 2 | | | | | | | | | 0.10 | | 0.20 | 0.20 | | | |
| Alkyl-polyglucoside | | | | | | | 0.60 | 0.50 | 0.50 | 0.40 | 0.40 | 0.40 | | | |
| Tri-ethanolamine | | | | 0.50 | | | | | | | | 0.50 | 0.50 | 0.50 | 0.50 |
| Glycol Ether 1 | | | 5.00 | | | | | | | | | | 2.40 | | |
| Glycol Ether 2 | | | | | | | | | | | | | | 2.40 | 2.40 |
| NaEDTA | | | | | | | | | | | | | | | |
| Sodium metasilicate pentahydrate | 0.10 | 0.10 | | | | | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | | | | |
| Sodium Carbonate | | | | | | | | | | | | | | | |
| STPP | | | | | | | | | | | | | | | |
| TKPP | | | | | | | | | | | | | | | |
| Water* | B | B | B | B | B | B | B | B | B | B | B | B | B | B | B |

Table 9 - Bathroom Cleaner Formulations

| **Component** | **B1** (wt %) | **B2** (wt %) | **B3** (wt %) | **B4** (wt %) | **B5** (wt %) | **B6** (wt %) | **B7** (wt %) | **B8** (wt %) | **B9** (wt %) | **B10** (wt %) | **B11** (wt %) | **B12** (wt %) | **B13** (wt %) | **B14** (wt %) | **B15** (wt %) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Polyethyl-oxazoline | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Quaternary ammonium compound | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Fragrance | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Amine Oxide | 0.84 | | 0.42 | 0.84 | | 0.42 | 0.84 | | 0.42 | 0.84 | | 0.42 | 0.84 | | 0.42 |
| Ethoxylated alcohol 1 | | 0.84 | | | 0.84 | | | 0.84 | | | 0.84 | | | 0.84 | |
| Ethoxylated alcohol 2 | | | 0.50 | | | 0.50 | | | 0.50 | | | 0.50 | | | 0.50 |
| Glycol Ether | | | | 4.00 | 4.00 | 4.00 | | | | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| NaEDTA | 2.90 | 2.90 | 2.90 | 2.90 | 2.90 | 2.90 | | | | | | | | | |
| Citric Acid | | | | | | | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 | | | |
| Sulfamic Acid | | | | | | | | | | | | | 2.50 | 2.50 | 2.50 |
| Water* | B | B | B | B | B | B | B | B | B | B | B | B | B | B | B |

It will therefore be readily understood by those persons skilled in the art that the present composition and methods are susceptible of broad utility and application. Many embodiments and adaptations other than those herein described, as well as many variations, modifications and equivalent arrangements, will be apparent from or reasonably suggested to one of ordinary skill by the present disclosure and the foregoing description thereof, without departing from the substance or scope thereof.

Accordingly, while the present composition and methods have been described herein in detail in relation to its preferred embodiment, it is to be understood that this

disclosure is only illustrative and exemplary and is made merely for purposes of providing a full and enabling disclosure.

The foregoing disclosure is not intended or to be construed to limit or otherwise to exclude any such other embodiments, adaptations, variations, modifications and equivalent arrangements.

What is claimed is:

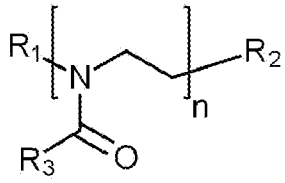
1. A disinfectant formulation imparting a residual biocidal property, the disinfectant formulation comprising:

a polymer binder, wherein the polymer binder is an oxazoline homopolymer or an extended or a modified polymer based on an oxazoline homopolymer,

a biocidal compound, and

a carrier.

2. The disinfectant formulation according to claim 1, wherein the oxazoline homopolymer has a structure of:




wherein

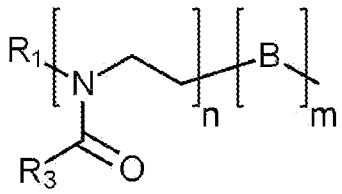
$R_1$ is a hydrogen, alkyl, alkenyl, alkoxy, alkylamino, alkynyl, allyl, amino, anilino, aryl, benzyl, carboxyl, carboxyalkyl, carboxyalkenyl, cyano, glycosyl, halo, hydroxyl, oxazolinium mesylate, oxazolinium tosylate, oxazolinium triflate, silyl oxazolinium, phenolic, polyalkoxy, quaternary ammonium, thiol, or thioether group;

$R_2$ is a hydrogen, alkyl, alkenyl, alkoxy, alkylamino, alkynyl, allyl, amino, anilino, aryl, benzyl, carboxyl, carboxyalkyl, carboxyalkenyl, cyano, glycosyl, halo, hydroxyl, oxazolinium mesylate, oxazolinium tosylate, oxazolinium triflate, silyl oxazolinium, phenolic, polyalkoxy, quaternary ammonium, thiol, or thioether group or a macrocyclic structure;

$R_3$ is a hydrogen, alkyl, alkenyl, alkoxy, aryl, benzyl, hydroxyalkyl, or perfluoroalkyl group; and

n is in a range of 1 to 1,000,000.

3. The disinfectant formulation according to claim 1, wherein the extended or the modified polymer based on the oxazoline homopolymer has a structure of:




wherein

$R_1$ is a hydrogen, alkyl, alkenyl, alkoxy, alkylamino, alkynyl, allyl, amino, anilino, aryl, benzyl, carboxyl, carboxyalkyl, carboxyalkenyl, cyano, glycosyl, halo, hydroxyl, oxazolinium mesylate, oxazolinium tosylate, oxazolinium triflate, silyl oxazolinium, phenolic, polyalkoxy, quaternary ammonium, thiol, or thioether group;

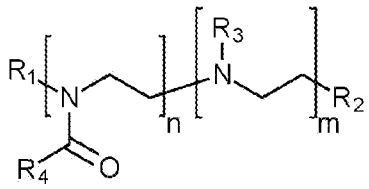
$R_3$ is a hydrogen, alkyl, alkenyl, alkoxy, aryl, benzyl, hydroxyalkyl, or perfluoroalkyl group;

n is in a range of 1 to 1,000,000;

B is a monomer repeating unit linked to oxazoline in a coploymer; and

m is in a range of 0 to 500,000.

4. The disinfectant formulation according to claim 3, wherein B is ethyleneimine having a structure of:




wherein

$R_1$ is a hydrogen, alkyl, alkenyl, alkoxy, alkylamino, alkynyl, allyl, amino, anilino, aryl, benzyl, carboxyl, carboxyalkyl, carboxyalkenyl, cyano, glycosyl, halo, hydroxyl, oxazolinium mesylate, oxazolinium tosylate, oxazolinium triflate, silyl oxazolinium, phenolic, polyalkoxy, quaternary ammonium, thiol, or thioether group;

$R_2$ is a hydrogen, alkyl, alkenyl, alkoxy, alkylamino, alkynyl, allyl, amino, anilino, aryl, benzyl, carboxyl, carboxyalkyl, carboxyalkenyl, cyano, glycosyl, halo, hydroxyl, oxazolinium mesylate, oxazolinium tosylate, oxazolinium triflate, silyl oxazolinium, phenolic, polyalkoxy, quaternary ammonium, thiol, or thioether group or a macrocyclic structure;

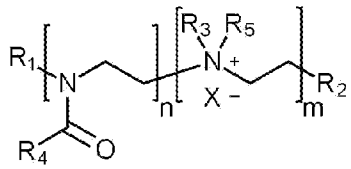
$R_3$ is hydrogen, alkyl, alkenyl, alkoxy, aryl, benzyl, hydroxyalkyl, or perfluoroalkyl;

$R_4$ is hydrogen, alkyl, alkenyl, alkoxy, aryl, benzyl, hydroxyalkyl, or perfluoroalkyl;

m is in a range of 0 to 500,000; and

n is in a range of 1 to 1,000,000.

5. The disinfectant formulation according to claim 3, wherein B has a structure of:




wherein

$R_1$ is a hydrogen, alkyl, alkenyl, alkoxy, alkylamino, alkynyl, allyl, amino, anilino, aryl, benzyl, carboxyl, carboxyalkyl, carboxyalkenyl, cyano, glycosyl, halo, hydroxyl, oxazolinium mesylate, oxazolinium tosylate, oxazolinium triflate, silyl oxazolinium, phenolic, polyalkoxy, quaternary ammonium, thiol, or thioether group;

$R_2$ is a hydrogen, alkyl, alkenyl, alkoxy, alkylamino, alkynyl, allyl, amino, anilino, aryl, benzyl, carboxyl, carboxyalkyl, carboxyalkenyl, cyano, glycosyl, halo, hydroxyl, oxazolinium mesylate, oxazolinium tosylate, oxazolinium triflate, silyl oxazolinium, phenolic, polyalkoxy, quaternary ammonium, thiol, or thioether group or a macrocyclic structure;

$R_3$ is hydrogen, alkyl, alkenyl, alkoxy, aryl, benzyl, hydroxyalkyl, or perfluoroalkyl;

$R_4$ is hydrogen, alkyl, alkenyl, alkoxy, aryl, benzyl, hydroxyalkyl, or perfluoroalkyl;

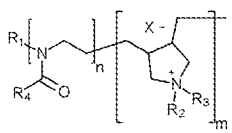
$R_5$ is hydrogen, methyl, ethyl, propyl, or another type of alkyl group;

m is in a range of 0 to 500,000;

n is in a range of 1 to 1,000,000; and

$X^-$, an anion, is a halogen, sulfonate, sulfate, phosphonate, phosphate, carbonate/bicarbonate, hydroxy, or carboxylate.

6. The disinfectant formulation according to claim 3, wherein B is a polyethyloxazoline modified with polydiallyldimethylammonium chloride having a structure of:




wherein

$R_1$ is a hydrogen, alkyl, alkenyl, alkoxy, alkylamino, alkynyl, allyl, amino, anilino, aryl, benzyl, carboxyl, carboxyalkyl, carboxyalkenyl, cyano, glycosyl, halo, hydroxyl, oxazolinium mesylate, oxazolinium tosylate, oxazolinium triflate, silyl oxazolinium, phenolic, polyalkoxy, quaternary ammonium, thiol, or thioether group;

$R_2$ is a short chain alkyl group;

$R_3$ is a short chain alkyl group;

$R_4$ is hydrogen, alkyl, alkenyl, alkoxy, aryl, benzyl, hydroxyalkyl, or perfluoroalkyl;

m is in a range of 0 to 500,000;

n is in a range of 1 to 1,000,000; and

$X^-$, an anion, is a halogen, sulfonate, sulfate, phosphonate, phosphate, carbonate, bicarbonate, hydroxy, or carboxylate.

7. The disinfectant formulation according to claim 3, wherein B is an olefin selected from the group consisting of diallyldimethylammonium chloride, styrene, methoxystyrene, methoxyethene, or another olefin.

8. The disinfectant formulation according to claim 1, wherein the polymer binder is prepared with a monomer of ethyloxazoline.

9. The disinfectant formulation according to claim 8, wherein ethyloxazoline is copolymerized with a heterocyclic monomer.

10. The disinfectant formulation according to claim 1, wherein the polymer binder employs a pendant oxazoline group on a polymer backbone.

11. The disinfectant formulation according to claim 10, wherein the polymer backbone is an acrylic or a styrene based polymer, or a copolymer containing acrylic or styrene.

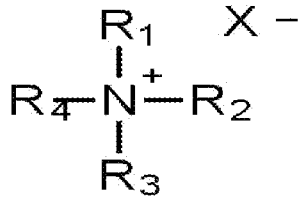
12. The disinfectant formulation according to claim 1, wherein the disinfectant formulation is in a form of a liquid.

13. The disinfectant formulation according to claim 12, wherein the polymer binder is present in a range of 0.1% to 20% based on the weight of the disinfectant formulation.

14. The disinfectant formulation according to claim 13, wherein the polymer binder is in a range of 0.1% to 10% based on the weight of the disinfectant formulation.

15. The disinfectant formulation according to claim 1, wherein the biocidal compound is selected from the group consisting of a quaternary ammonium compound, citric acid, sulfamic acid, glycolic acid, lactic acid, lauric acid, and capric acid, silane quaternary salts, triclosan, zinc pyrithione, metal salt, metal oxide, phenol, botanical, halogen, peroxide, heterocyclic antimicrobial, aldehyde, alcohol, and a combination thereof.

16. The disinfectant formulation according to claim 15, wherein the quaternary ammonium compound has a structure of:



wherein

$R_1$ is alkyl, alkoxy, or aryl, either with or without heteroatoms, or saturated or non-saturated;

$R_2$ is alkyl, alkoxy, or aryl, either with or without heteroatoms, or saturated or non-saturated;

$R_3$ is alkyl, alkoxy, or aryl, either with or without heteroatoms, or saturated or non-saturated;

$R_4$ is alkyl, alkoxy, or aryl, either with or without heteroatoms, or saturated or non-saturated;

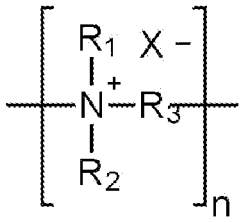
$X^-$, an anion, is halogen, sulfonate, sulfate, phosphonate, phosphate, carbonate, bicarbonate, hydroxy, or carboxylate.

17. The disinfectant formulation according to claim 15, wherein the quaternary ammonium compound is selected from the group consisting of n-alkyl dimethyl benzyl ammonium chloride, di-n-octyl dimethyl ammonium chloride, dodecyl dimethyl ammonium chloride, n-alkyl dimethyl benzyl ammonium saccharinate, 3-(trimethoxysilyl) propyldimethyloctadecyl ammonium chloride, and a combination thereof.

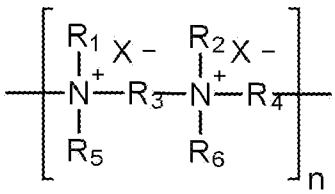
18. The disinfectant formulation according to claim 15, wherein the quaternary ammonium compound is present in a composition comprising: N-alkyl dimethyl benzyl ammonium chloride, N-octyl decyl dimethyl ammonium chloride, di-n-decyl dimethyl ammonium chloride, and di-n-dioctyl dimethyl ammonium chloride.

19. The disinfectant formulation according to claim 18, wherein the composition comprises: 40 weight % of N-alkyl dimethyl benzyl ammonium chloride, 30 weight % of N-octyl decyl dimethyl ammonium chloride, 15 weight % of di-n-decyl dimethyl ammonium chloride, and 15 weight % of di-n-dioctyl dimethyl ammonium chloride, wherein the percentage is a weight percentage of individual quaternary ammonium compounds based on the total weight of the composition.

20. The disinfectant formulation according to claim 15, wherein the quaternary ammonium compound is a polymeric version having a structure of:



or



wherein

$R_1$ is hydrogen, methyl, ethyl, propyl or other carbon alkyl group;

$R_2$ is hydrogen, methyl, ethyl, propyl or other carbon alkyl group;

$R_3$ is methylene, ethylene, propylene or other alkylene linking group;

$R_4$ is methylene, ethylene, propylene or other alkylene linking group;

$R_5$ is hydrogen, methyl, ethyl, propyl or other carbon alkyl group;

$R_6$ is hydrogen, methyl, ethyl, propyl or other carbon alkyl group; and

n is in a range of 2 to 10,000.

21. The disinfectant formulation according to claim 20, wherein the polymeric version is a cationic polymer.

22. The disinfectant formulation according to claim 22, wherein the cationic polymer is a polyamine derived from dimethylamine and epichlorohydrin.

23. The disinfectant formulation according to claim 15, wherein the quaternary ammonium compound is poly diallyldimethylammonium chloride, polyDADMAC, or a compound comprising a biguanide moiety in the molecule.

24. The disinfectant formulation according to claim 12, wherein the biocidal compound is present in a range of 0.05% to 10% based on the weight of the disinfectant formulation.

25. The disinfectant formulation according to claim 1, wherein the carrier comprises a solvent or a mixture of solvents.

26. The disinfectant formulation according to claim 25, wherein the solvent or mixture of solvents comprise water, a low molecular weight alcohol, alkylene glycol ether, a terpene or terpene derivative, and a combination thereof.

27. The disinfectant formulation according to claim 1, further comprising a corrosion inhibitor.

28. The disinfectant formulation according to claim 1, further comprising a surfactant or a wetting agent.

29. The disinfectant formulation according to claim 28, wherein the surfactant is present in a range of 0.01% to 10%.

30. A liquid disinfectant formulation imparting a residual biocidal property, the disinfectant formulation comprising:

0.1 % to 20% of a polymer binder, wherein the polymer binder is an oxazoline homopolymer or an extended or a modified polymer based on an oxazoline homopolymer,

0.05% to 2% of a biocidal compound,

0% to 99.9% of water, and

0.01% to 2% of a surfactant.

31. A liquid disinfectant formulation imparting a residual biocidal property, the disinfectant formulation comprising:

0.1 % to 20% of a polymer binder, wherein the polymer binder is an oxazoline homopolymer or an extended or a modified polymer based on an oxazoline homopolymer,

0.05% to 10% of a biocidal compound,

0% to 99.9% of water,

0.1% to 10% of a non-ionic surfactant, and

1% to 10% glycol ether solvent.

32. An article treated with the disinfectant formulation according to claim 1.

33. The article according to claim 1, wherein the article is in a form of a wipe or other disposable product.

34. A method of using a disinfectant formulation according to claim 1, comprising treating a surface with the disinfectant formulation to impart a film having a capacity to

quickly kill bacteria and other germs for at least 24 hours after deposit of the film on the treated surface.

35. The method according to claim 34, wherein treating occurs by an application method selected from the group consisting of spraying, fogging, rolling, brushing, mopping, wiping, and a combination thereof.

# INTERNATIONAL SEARCH REPORT

International application No
PCT/US 15/62475

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - C08G 73/00; C08L 101/00; A01N 33/12 (2016.01)
CPC - C08L 101/00; A01N 33/12; C08G 73/0233
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
CPC: C08L101/00; A01N33/12; C08G73/0233
IPC(8): C08C 73/00; C08L 101/00; A01N 33/12 (2016.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 525/142; 525/440.04 (See Search Words Below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PATBASE: Full-text = AU BE BR CA CH CN DE DK EP ES FI FR GB IN JP KR SE TH TW US WO
Google: Scholar/Patents: homopolymer ethyloxazoline ammonium styrene disinfectant dimethylamine epichlorohydrin cationic polymer diallyl dimethyl octyl decyl ammonium chloride wipe biocide water residual surface glycol surfactant oxazoline

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | WO 2011/064554 A1 (BYOTROL PLC) 03 June 2011 (03.06.2011) pg 2, ln 24-32; pg 6,ln 4-8; pg 10, ln 15-16; pg 11, ln 12-20;pg 11, ln 25-32; pg 12, ln 30-33; pg 14, ln 8-12, Table; pg 17, ln 10-29; pg 25, ln 33 to pg 26, ln 5; pg 33, ln 15-25; pg 34, ln 4-7; pg 34, ln 14-15; pg 34, ln 33-34; pg 35, ln 1-6; pg 39, ln 19-23; pg 40, ln 25 to pg 41, ln 8; pg 42,ln 5-6 | 1-35 |
| Y | US 4,481,167 A (GINTER et.al.) 06 November 1984 (06.11.1984) Col 1, ln 15-20; Col 2, ln 13-25; Col 3, ln 1-54; Col 4,ln 22-40; Col 7, ln 6-15 | 1-35 |
| Y | US 2005/0008676 A1 (QIU et.al.) 13 January 2005 (13.01.2005) para [0047];[0054]-[0056];[0064];[0065]; [0069];[0090]; [0091] | 5-7;10;11;23 |
| Y | US 5,051,124 A (PERA) 24 September 1991 (24.09.1991) abstract; Col 2, ln 58-67 | 22 |

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 18 January 2016 (18.01.2016) | 05 FEB 2016 |
| Name and mailing address of the ISA/US<br>Mail Stop PCT, Attn: ISA/US, Commissioner for Patents<br>P.O. Box 1450, Alexandria, Virginia 22313-1450<br>Facsimile No. 571-273-8300 | Authorized officer:<br>Lee W. Young<br>PCT Helpdesk: 571-272-4300<br>PCT OSP: 571-272-7774 |

Form PCT/ISA/210 (second sheet) (January 2015)