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(54) **METHOD FOR SANITIZING, DISINFECTING AND BLEACHING LAUNDRY**

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(57) **ABSTRACT**

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**Related U.S. Application Data**

(60) Division of application No. 12/726,073, filed on Mar. 17, 2010, which is a continuation of application No. 10/754,491, filed on Jan. 9, 2004, now Pat. No. 7,682,403.

A method for sanitizing, disinfecting and bleaching laundry is provided. The method includes steps of applying an antimicrobial composition at a pH from about 4 to about 9 in an industrial laundry washing machine for effective antimicrobial efficacy, and thereafter applying a detergent use solution at an alkaline pH for removal of soil from the laundry, and optionally applying a bleach activator and/or catalyst to boost the bleaching component of the antimicrobial composition on the laundry, and lastly draining the antimicrobial composition, the detergent use solution and the bleach catalyst composition from the laundry.

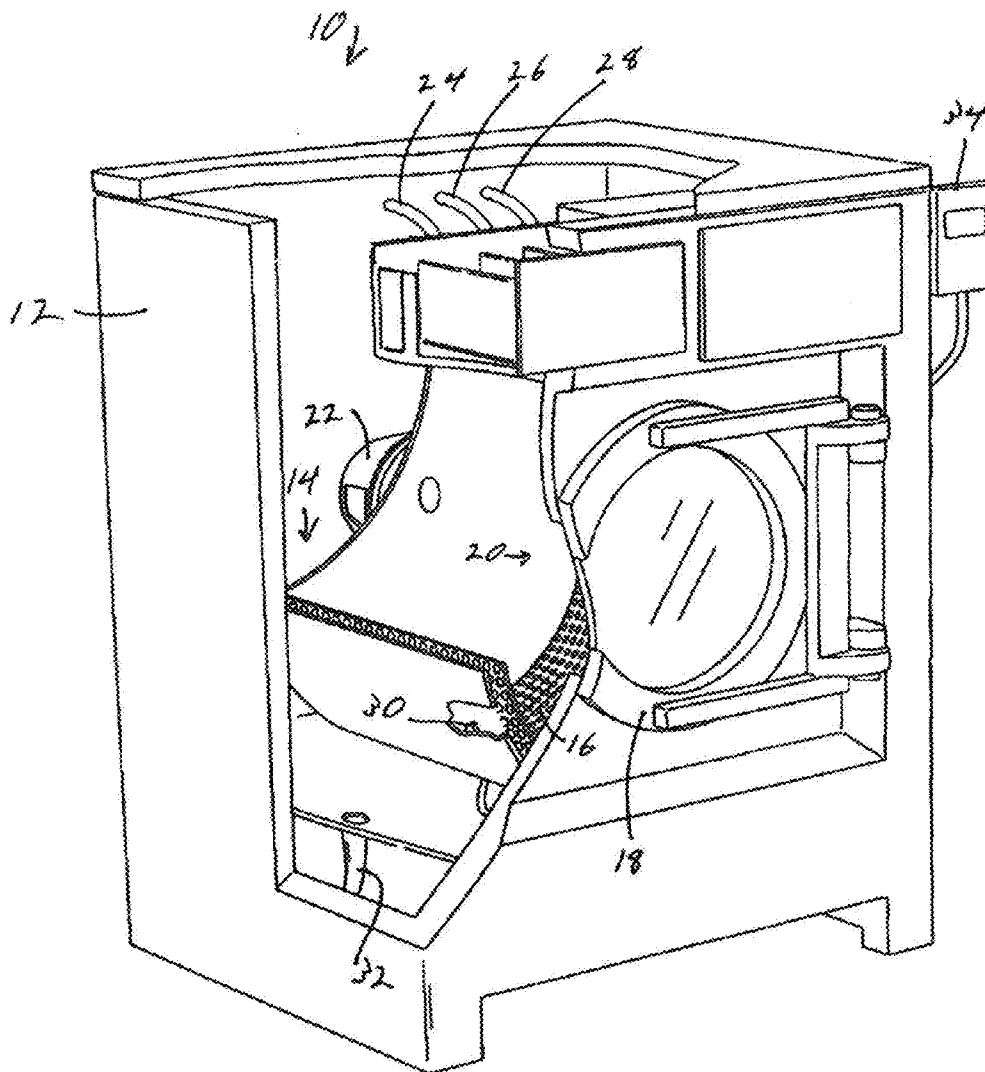
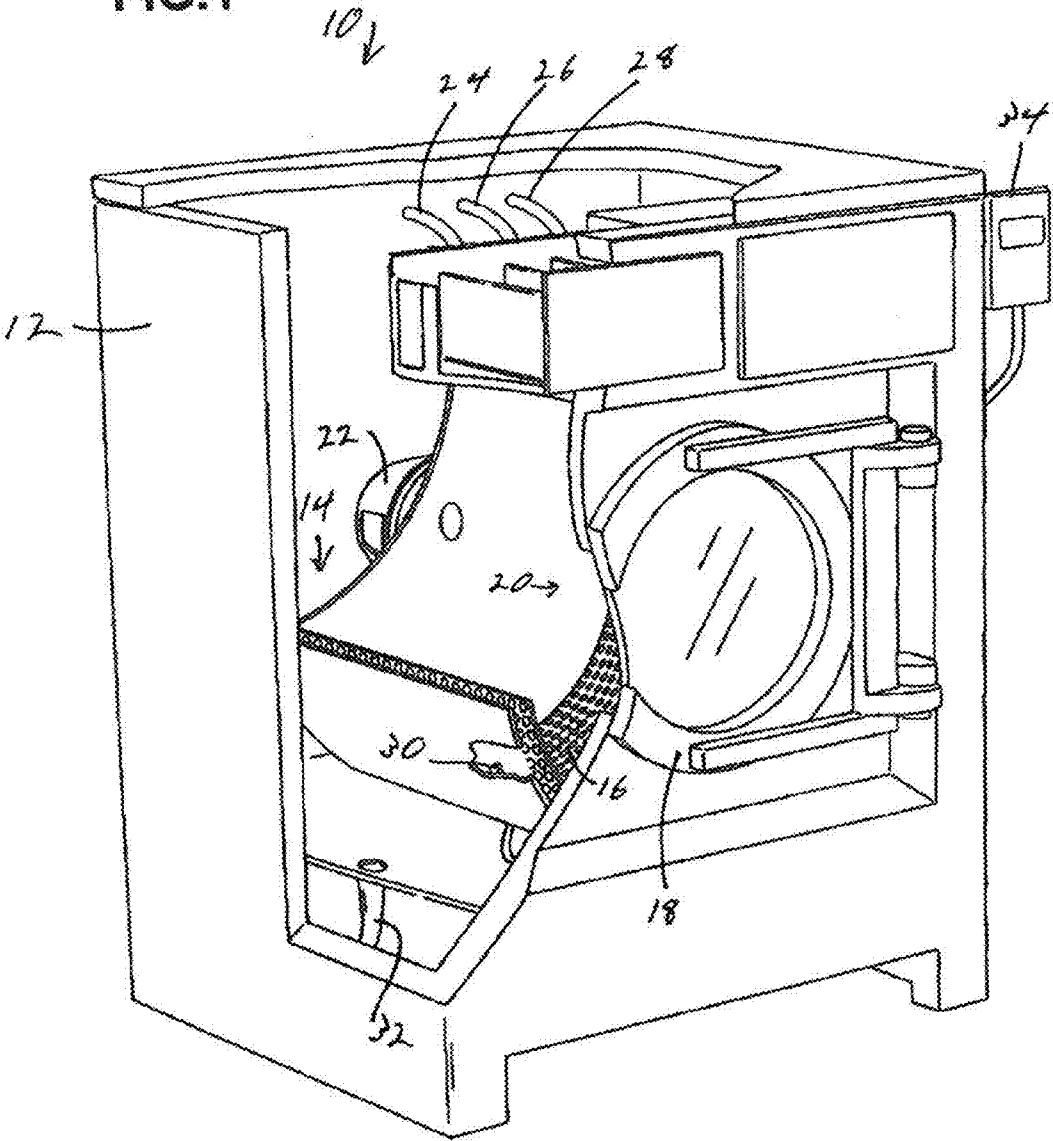


FIG.1



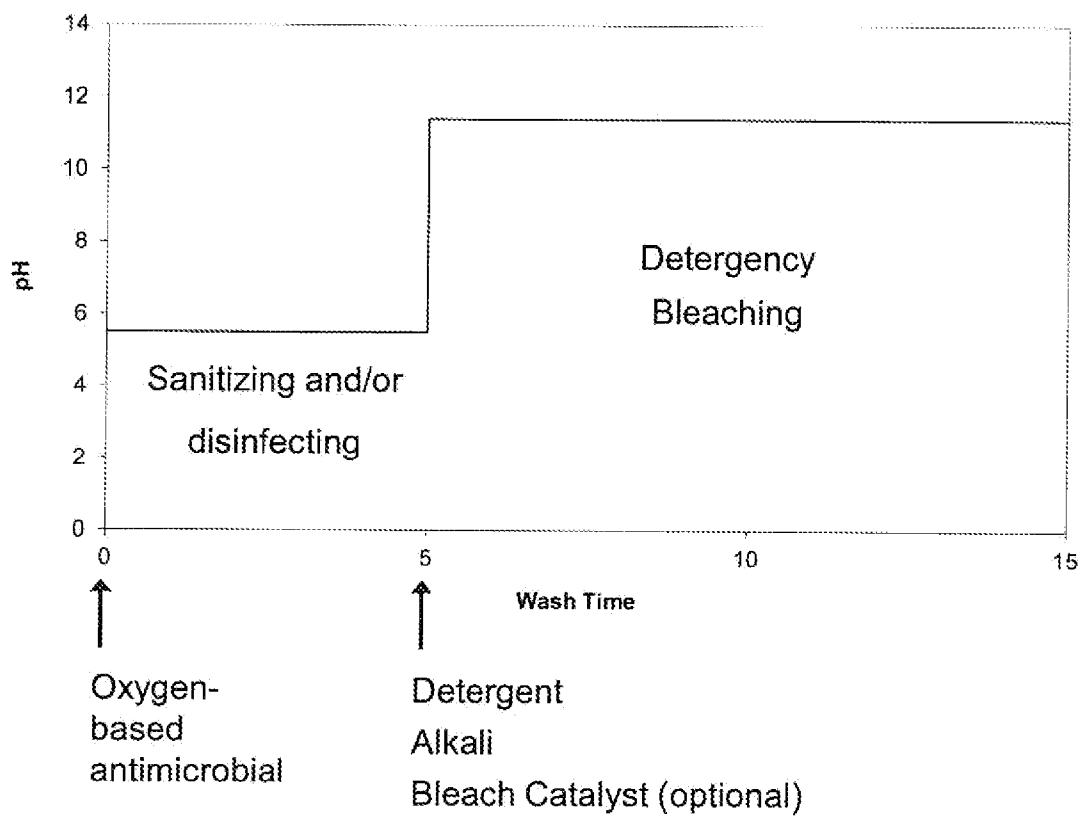


FIGURE 2

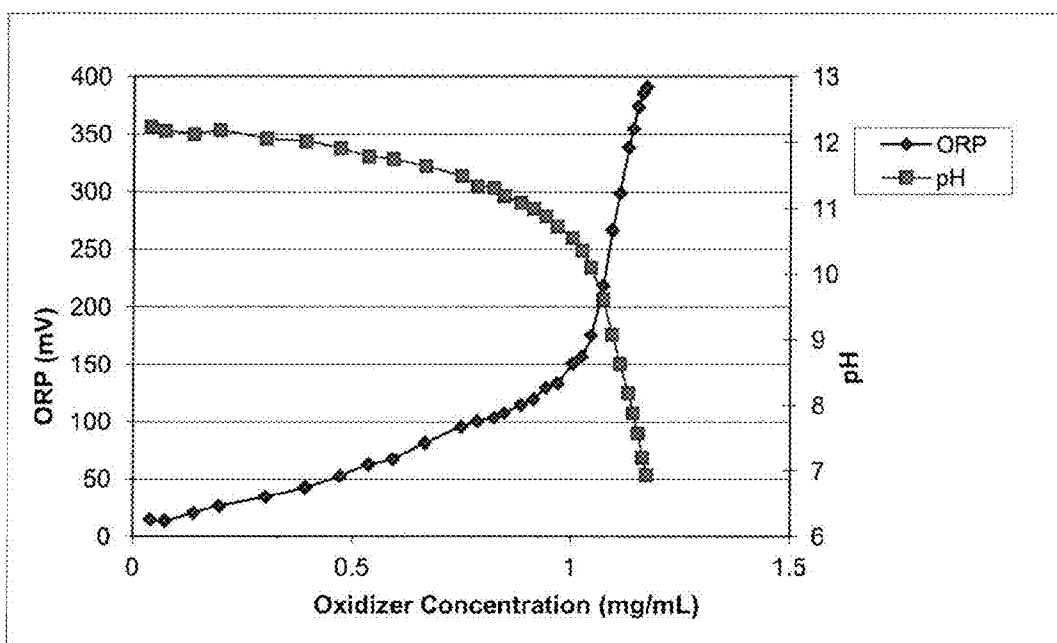


FIGURE 3

## METHOD FOR SANITIZING, DISINFECTING AND BLEACHING LAUNDRY

### CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a divisional of U.S. patent application Ser. No. 12/726,073, filed on Mar. 17, 2010, which is a continuation of U.S. patent application Ser. No. 10/754,491, filed on Jan. 9, 2004, now U.S. Pat. No. 7,682,403, the entire disclosures are incorporated herein by reference in their entirety.

### FIELD OF THE INVENTION

[0002] The invention is directed at a method for sanitizing, disinfecting and bleaching laundry, and an apparatus for treating laundry. In particular, laundry can be treated by washing the laundry with an antimicrobial composition at a first pH for effective antimicrobial efficacy, thereafter applying a detergent use solution, which may optionally contain a bleach activator and/or catalyst, at a second pH for removal of soil from the laundry, and lastly draining the antimicrobial composition, the detergent use solution, and the bleach activator/catalyst from the laundry. This method for treating laundry can be provided as part of a laundry cleaning operation and can be utilized in industrial and commercial applications.

### BACKGROUND

[0003] In industrial and commercial laundry facilities, textile materials such as sheets, towels, wipes, garments, table cloths, etc. are laundered at elevated temperatures with alkaline detergents. The alkaline detergents typically contain a source of alkalinity such as an alkali metal hydroxide, alkali metal silicate, alkali metal carbonate or other base component. Additionally, the alkaline detergents typically contain surfactants or other detergent materials that can enhance soil removal from the textile materials. The detergents can also contain other components such as bleaches, brightening agents, anti-redeposition agents, etc. that are used to enhance the appearance of the resulting textile materials. These detergent components may also optionally be dosed separately from the alkaline detergent, but will all be mixed together in the laundry wash bath. The textile materials that have been treated with an alkaline detergent are typically treated with a commercial or industrial sour composition that contains acid components for neutralizing alkaline residues on the fabric to enhance skin compatibility. A fabric sour composition that provides sanitizing properties is described by U.S. Pat. No. 6,262,013 to Smith et al.

[0004] In a conventional, industrial laundry washing facility, textile materials can be subjected to several treatment steps in an industrial sized laundry washing machine to provide cleaning. Exemplary treatment steps include a presoak step, a wash step that often occurs at a pH of about 11 to 12, a rinse step and/or multiple rinse steps for the removal of soil containing wash liquor which incrementally lower the pH, and a sour step that brings the final pH to about 5 to 7, and an extract step that often involves spinning the textiles to remove water. An antimicrobial composition is typically applied concurrently with the detergent, as in an all-in-one product, or during the sour step where it is afforded a minimum contact time in the absence of other cleaning chemicals.

[0005] Efforts are underway to improve the industrial laundry washing techniques and provide a reduction in processing time, cost of materials, materials consumption, energy costs, and water consumption.

[0006] In the instant invention, a wash process is proposed in which the antimicrobial composition is dosed first, and given a contact time devoid of any other chemicals, followed by the detergent composition, alkali and optionally bleach activator and/or catalyst. This differs from conventional usage by placing the sanitizing step prior to the wash step, rather than following it. This new proposed wash process has three fundamental benefits: 1) bleach activators and/or catalysts may now be used with oxygen based antimicrobial composition for improved stain removal and antimicrobial activity; 2) medium to long chain fatty acid antimicrobial composition may now be used, which may otherwise leave a residue on the fabric when dosed after the detergent compositions, and; 3) low acid antimicrobial compositions may now be used, which may be insufficient to lower the pH when used after a highly alkaline detergent.

[0007] Other objects, aspects and advantages of this invention will be apparent to one skilled in the art in view of the following disclosure, the drawings, and the appended claims.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1 is a perspective, partial cutaway view of a laundry washing machine according to the principles of the present invention.

[0009] FIG. 2 is a schematic diagram of the wash process of the present invention.

[0010] FIG. 3 is a graph depicting the results of an oxidation-reduction potential (ORP) as a function of an antimicrobial composition concentration and pH of the present invention.

### SUMMARY OF THE INVENTION

[0011] A method for treating laundry is provided according to the invention. The method includes steps of washing the laundry with a sanitizing use solution at a pH from about 4 to about 9 in a laundry washing machine, and thereafter applying a detergent use solution at an alkaline pH for removal of soil from the laundry, and thereafter optionally applying a bleach catalyst to boost the bleaching component of the sanitizing use solution on the laundry, and lastly draining the sanitizing use solution, the detergent use solution and the bleach catalyst from the laundry.

[0012] An oxygen-based antimicrobial use solution is provided according to the invention. The oxygen based antimicrobial use solution is selected from the group consisting of hydrogen peroxide, peroxy-carboxylic acids, including those formed from medium to long chain fatty acids with reduced water solubility, oxygen antimicrobial solutions comprised of the above ingredients but with low acid levels and mixtures thereof.

[0013] A laundry washing machine is provided according to the invention. The laundry washing machine includes a drum having an interior for holding laundry, a motor constructed and arranged for rotating the drum, a water inlet for introducing water into the drum interior, a chemical inlet for introducing chemicals into the drum interior, a drain for allowing fluid to drain from the drum interior, and a processing unit constructed for operating the laundry washing machine. The processing unit can be constructed to provide a

washing cycle for washing laundry with a sanitizing use solution at a pH from about 4 to about 9, and a detergent use solution and optionally a bleach activator and/or catalyst cycle for removing soil from the laundry and boosting the bleaching component of the sanitizing use solution at an alkaline pH.

[0014] While multiple embodiments are disclosed, still other embodiments of the present invention will become apparent to those skilled in the art from the following detailed description, which shows and describes illustrative embodiments of the invention. Accordingly, the detailed description is to be regarded as illustrative in nature and not restrictive.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] So that the invention may be more readily understood, certain terms are first defined and certain test methods are described.

[0016] It should be noted that, as used in this specification and the appended claims, the singular forms “a,” “an,” and “the” include plural referents unless the content clearly dictates otherwise. Thus, for example, reference to a composition containing “a compound” includes a composition having two or more compounds. It should also be noted that the term “or” is generally employed in its sense including “and/or” unless the content clearly dictates otherwise.

[0017] The term “about,” as used herein, modifying the quantity of an ingredient in the compositions of the invention or employed in the methods of the invention refers to variation in the numerical quantity that can occur, for example, through typical measuring and liquid handling procedures used for making concentrates or use solutions; through inadvertent error in these procedures; through differences in the manufacture, source, or purity of the ingredients employed to make the compositions or carry out the methods; and the like. The term about also encompasses amounts that differ due to different equilibrium conditions for a composition resulting from a particular initial mixture. Whether or not modified by the term “about,” the claims include equivalents to the quantities. All numeric values are herein assumed to be modified by the term “about,” whether or not explicitly indicated. The term “about” generally refers to a range of numbers that one of skill in the art would consider equivalent to the recited value (i.e., having the same function or result). In many instances, the terms “about” may include numbers that are rounded to the nearest significant figure.

[0018] It should be understood that the term “laundry” refers to items or articles that are cleaned in a laundry washing machine. In general, laundry refers to any item or article made from or including textile materials, woven fabrics, non-woven fabrics, and knitted fabrics. The textile materials can include natural or synthetic fibers such as silk fibers, linen fibers, cotton fibers, polyester fibers, polyamide fibers such as nylon, acrylic fibers, acetate fibers, and blends thereof including cotton and polyester blends. The fibers can be treated or untreated. Exemplary treated fibers include those treated for flame retardancy.

[0019] It should be understood that the term “linen” is often used to describe certain types of laundry items including bed sheets, pillow cases, towels, table linen, table cloth, bar mops and uniforms. The invention additionally provides a composition and method for treating non-laundry articles and surfaces including hard surfaces such as dishes, glasses, and other ware.

[0020] The laundry treatment composition can provide for antimicrobial and bleaching treatment and can be referred to as the antimicrobial and bleaching composition or more simply as the treatment composition. The treatment composition can be provided in the form of a concentrate that is diluted with water to provide a use solution. The use solution can be used for washing articles such as laundry.

[0021] The method for treating laundry according to the invention can be provided as part of an overall method for cleaning laundry according to the invention. That is, as part of a laundry cleaning operation, the laundry can be treated with an antimicrobial and bleaching composition to provide antimicrobial and bleaching properties. The antimicrobial properties can be characterized as sanitizing when there is a substantial reduction of bacteria, fungi, spores, and other microorganisms or microorganism generating materials on a surface being treated to provide a sanitized surface. A substantial reduction refers to a reduction of at least three orders of magnitude and can be referred to as a three-log<sub>10</sub> reduction. Preferably, the reduction can be at least five orders of magnitude.

[0022] The reference to “cleaning” refers to at least one of the removal of soil, the removal of staining or the appearance of staining, and the reduction of a population of microbes. A cleaning process can include all three of the removal of soil, the removal of staining or the appearance of staining, and the reduction of a population of microbes.

[0023] The method for treating laundry refers to the treatment of laundry with an antimicrobial composition at a pH from about 4 to about 9 and then treatment with a detergent use solution and optionally a bleach activator and/or catalyst at a different alkaline pH, preferably at a pH from about 9 to about 13. The first treatment favors antimicrobial properties, whereas, the second treatment favors soil removal and bleaching properties. In the context of the statement that a first treatment favors antimicrobial properties and a second treatment favors soil removal and bleaching properties, it should be understood that the term “favors” reflects a general preference for a particular activity at the identified condition such as a pH environment. In general, it is expected that the preference refers to a speed and sufficiency that provides desirable results whether the operation is carried out commercially or residentially. That is, antimicrobial properties are expected to occur sufficiently quickly when antimicrobial properties are favored, and bleaching properties are expected to occur sufficiently quickly when bleaching properties are favored. Although a particular activity may be favored in one environment, other activities can also occur in that environment. For example, although antimicrobial properties may be favored at the first treatment, it is expected that bleaching properties may also occur at the first treatment. Similarly, although the second treatment may favor bleaching properties, it is expected that a certain amount of antimicrobial properties may occur at the second treatment. It should be understood that characterizing a condition as favoring a particular activity does not require the absence of another activity at that condition.

[0024] The method for treating laundry can be provided in a commercial and/or industrial laundry washing facility and can be provided in a residential and/or home laundry washing machine that is programmable. Exemplary commercial and/or industrial laundry washing facilities include those cleaning textiles for the rental, health care, and hospitality industries. In addition, the method for treating laundry can occur as part

of an operation that includes additional steps, such as, washing, rinsing, finishing, and extracting. In addition, it should be understood that the step of treating laundry can include, as part of the step, additional activities such as, for example, washing and finishing.

**[0025]** It is expected that many commercial and industrial laundry washing machines are capable of handling the method for treating laundry according to the invention. Many commercial and industrial laundry washing machines are computer programmable, and computer programs can be provided to operate the machines according to the invention. In addition, it is expected that machines can be made available to treat laundry according to the invention, and that these machines can be used in both industrial and commercial applications and in home and residential applications. In addition, the treatment composition can be formulated so that it can be used in commercial and industrial laundry washing machines and residential laundry washing machines that are in common use, and are computer programmable, without modification. That is, it is expected that conventional laundry washing machines can be used to treat laundry according to the invention.

**[0026]** An exemplary laundry washing machine is shown in FIG. 1 at reference number 10. The laundry washing machine 10 can be characterized as a front loading washer. Although a front loading washer is shown, it should be understood that the principles of the invention apply to a top loading washer. Laundry washing machines that can be used according to the invention can be characterized as horizontal axis or vertical axis washers depending upon the axis of rotation. The laundry washing machine 10 can be characterized as a horizontal axis washer. In addition, tunnel washers and continuous bath washers can be utilized according to the invention.

**[0027]** The laundry washing machine 10 includes a housing 12. Within the housing 12 is provided a drum 14 that rotates to provide agitation between laundry and the wash liquor. The wash liquor refers to the liquid composition in contact with the laundry. The wash liquor can include a detergent use composition, a bleaching and antimicrobial composition, a rinse composition, a finishing composition, etc. The drum 14 includes an interior surface 16 for holding the laundry. A door 18 is provided for accessing the drum 14 opening 20 to move laundry into and out of the laundry washing machine 10.

**[0028]** A motor 22 is provided for causing the drum 14 to rotate. A chemical feed 24 is provided for introducing chemical into the drum 14. The chemical introduced can be a detergent composition, a bleaching and antimicrobial composition, a finishing composition, etc. A water inlet 26 is provided for introducing water into the drum 14. The water can be introduced through the water inlet 26 for diluting the chemical introduced through the chemical line 24. Alternatively, water can be combined with the chemicals to dilute the chemicals to provide a use composition and then introduced through the chemical line 24. It is expected that water will be introduced through the water inlet 26 at least for the purpose of rinsing the laundry. Additionally provided is a second chemical inlet 28. The second chemical inlet 28 can be provided for introducing various chemicals into the drum 14. For example, the second chemical inlet 28 can be used to introduce a pH adjusting agent to change the pH of the composition provided within the drum 14. It should be understood that the second chemical inlet 28 can be considered optional. For example, the treatment composition can be provided so that a condition shift, such as a pH shift, occurs without the addition

of another ingredient. In addition, if the treatment composition is provided that utilizes the addition of another component such as a pH adjusting agent, the component can be introduced through the chemical line 24.

**[0029]** A sensor 30 can be provided for sensing the conditions within the drum 14. That is, the liquor inside the drum 14 can pass through the drum interior 16 and contact with the sensor 30. The sensor can report pH conditions within the drum 14. If desired, the sensor can report other conditions or additional conditions including temperature and/or concentration.

**[0030]** The laundry washing machine 10 includes a drain 32 and a processor 34. The processor 34 is provided for operating the laundry washing machine 10. The processor 34 can be programmable to provide for operating the laundry washing machine 10 according to the method of the invention. In addition, the processor 34 can be provided for running the machine 10 and can be provided as the interface for dispensing. It should be understood that a processor is not a required component for treating laundry according to the invention. For example, the laundry washing machine can have a timer that causes the machine to move through various steps or operations, and the antimicrobial and bleaching treatments can be provided as part of a washing or finishing step, or can be provided as a separate step.

**[0031]** The method for treating laundry according to the invention includes an antimicrobial treatment and a soil removal/bleaching treatment. The antimicrobial treatment will precede the steps of washing the laundry with a detergent use solution. There may also be moderate stain removal, i.e. bleaching, from the antimicrobial treatment during this step. In some applications, a bleach activator and/or catalyst may optionally be added simultaneously with detergent during the alkaline washing step. This will improve the bleaching performance over what happens solely during the antimicrobial treatment step.

**[0032]** A schematic diagram illustrating the wash process of the current invention is shown in FIG. 2. The laundry can be treated with an antimicrobial composition to provide a desired level microbe removal. While there may be some stain removal, it may be less than desired. In the context of one embodiment of a laundry washing operation, it is expected that the laundry will first undergo an antimicrobial treatment and then undergo a laundry washing step in the presence of a detergent use solution. The detergent use solution may optionally contain a bleach activator and/or catalyst which will further improve the stain removal compared to the antimicrobial treatment alone. Alternatively, at least a portion of the detergent use solution can be drained from the laundry and the laundry can be rinsed to further remove the detergent use solution from the laundry prior to the step of treating the laundry with a bleach activator and/or catalyst. Various techniques for washing laundry with a detergent use solution can be utilized according to the invention for cleaning laundry prior to the step of treating with a bleaching composition. The detergent use solution can be a neutral to highly alkaline detergent use solution. Various techniques for cleaning that include alkaline cleaning are described in United States Patent Application Publication No. 20030162682 that was filed with the United States Patent and Trademark Office on Aug. 28, 2003, and U.S. Pat. No. 6,194,371 that was filed on Feb. 7, 2001, the entire disclosures of which is incorporated herein by reference. Additional techniques for cleaning laundry are described in U.S. application Ser. No. 10/600,091 that

was filed with the United States Patent and Trademark Office on Jun. 20, 2003, the entire disclosure of which is incorporated herein by reference. In general, it is expected that an alkaline wash refers to a wash that takes place at a pH at between about 7 and about 13, and can include a pH of between about 8 and about 12.

**[0033]** When the laundry is treated with a composition such as a detergent composition prior to the step of treating with the bleaching activator and/or catalyst, it is expected that a certain amount of carryover alkalinity may occur. It should be understood that the phrase "carryover alkalinity" refers to the chemistry that is contained within the laundry (that has not been completely removed) that is available for the next step. For example, when the detergent use solution provides an alkaline environment, it is expected that the detergent use solution will provide a certain amount of carryover alkalinity for a subsequent bleaching treatment step unless all of the detergent use solution is removed by rinsing. By expecting a carryover effect, one can select the bleaching composition that takes advantage of the carryover effect.

**[0034]** When the detergent use solution includes a source of alkalinity, unless all of the detergent use solution is removed during a rinsing step, it is expected that some amount of the alkalinity will remain and provide an environment during the treatment step that is relatively alkaline. Because many detergent use solutions provide a generally alkaline environment and because bleaching is generally favored in an alkaline environment, it is expected that the step of treating with a bleaching composition can be provided at a pH that favors bleaching. Accordingly, it is possible to take advantage of the carryover alkalinity by providing a bleaching composition in an alkaline environment.

**[0035]** It should be understood that the pH of the bleaching operation can be affected as a result of alkalinity during the washing step or carryover of that alkalinity if the bleaching follows the washing step.

#### Antimicrobial and Bleaching Treatment Compositions

**[0036]** The antimicrobial and bleaching compositions can be referred to as treatment compositions, and the step of treating using the antimicrobial and bleaching compositions can be referred to as the treatment steps. The treatment compositions, when in use, can be referred to as the treatment use composition or the treatment use solution. During the treatment step, it is desirable to provide the treatment use composition at a pH that favors antimicrobial treatment first at a relatively low pH to effect a desired level of antimicrobial treatment and the bleaching at a higher pH in order to effect the desired level of bleaching through use of a bleach activator and/or catalyst which is most effective at alkaline pH. Moreover, in order to take advantage of the possibly carryover effect from a washing step that uses an alkaline detergent use solution, it can be advantageous to first favor an antimicrobial treatment at a relatively low pH, then perform a washing step with an alkaline detergent that provides the bleaching operation with a pH that favors bleaching.

**[0037]** When the antimicrobial composition is provided at a pH that favors antimicrobial properties, it is desirable to provide the pH at a level and time sufficient to provide the desired antimicrobial effect. It can be expected that the pH will be provided at between about 4 to about 9. The length of time sufficient to provide a desired level of antimicrobial effect often depends on the laundry washing machine that is being used. In general, it is expected that sufficient antimicrobial

effect can occur at a time of between about 1 and about 20 minutes, at a time of between about 2 and about 15 minutes, and a time of between about 3 minutes and about 10 minutes. Increasing the pH optionally allows the use of bleach activators and/or catalysts which are typically most effective at alkaline pH. The pH of the treatment composition for providing bleaching properties can be between about 9 to about 13. In general, it is expected that sufficient bleaching can occur at a time of between about 1 and about 20 minutes, at a time of between about 2 and about 15 minutes, and a time of between about 3 minutes and about 10 minutes.

#### Antimicrobial Agent

**[0038]** The antimicrobial composition can include an agent or agents that provide antimicrobial properties, exemplary antimicrobial agents include peroxycarboxylic acids, including those derived from minimally soluble medium to long chain fatty acids, as well as peroxycarboxylic acid compositions containing low acid actives and mixtures thereof.

**[0039]** For example, the antimicrobial composition can be a peroxycarboxylic acid, such as a mono- or di-peroxycarboxylic acid or an ester peroxycarboxylic acid, an alkali metal salt including these types of compounds, or an adduct of such a compound. Exemplary peroxycarboxylic acids include C<sub>1</sub>-C<sub>24</sub> peroxycarboxylic acid, salt of C<sub>1</sub>-C<sub>24</sub> peroxycarboxylic acid, ester of C<sub>1</sub>-C<sub>24</sub> peroxycarboxylic acid, diperoxycarboxylic acid, salt of diperoxycarboxylic acid, ester of diperoxycarboxylic acid, or mixtures thereof.

**[0040]** Exemplary peroxycarboxylic acids include C<sub>1</sub>-C<sub>10</sub> aliphatic peroxycarboxylic acid, salt of C<sub>1</sub>-C<sub>10</sub> aliphatic peroxycarboxylic acid, ester of C<sub>1</sub>-C<sub>10</sub> aliphatic peroxycarboxylic acid, or mixtures thereof; salts of or adducts of peroxyacetic acid such as peroxyacetyl borate. Exemplary diperoxycarboxylic acids include C<sub>4</sub>-C<sub>10</sub> aliphatic diperoxycarboxylic acid, salt of C<sub>4</sub>-C<sub>10</sub> aliphatic diperoxycarboxylic acid, or ester of C<sub>4</sub>-C<sub>10</sub> aliphatic diperoxycarboxylic acid, or mixtures thereof; and sodium salt of perglutaric acid, of per-succinic acid, of peradipic acid, or mixtures thereof. Additional exemplary peroxycarboxylic acids include phthalimido-percarboxylic acid such as phthalimidoperhexanoic acid and phthalimidoperoctanoic as described in U.S. application Ser. No. 10/168,426 filed on Jun. 21, 2002, the entire disclosure being incorporated herein by reference.

**[0041]** The antimicrobial composition can include one or more carboxylic acids and one or more peroxycarboxylic acids with a peroxygen compound such as hydrogen peroxide, H<sub>2</sub>O<sub>2</sub>. Typically, however, the composition contains one or more carboxylic acids, an oxidizer, and one or more peroxycarboxylic acids depending on equilibrium. The peroxycarboxylic acid material can be made by oxidizing a carboxylic acid directly to the peroxycarboxylic acid material which is then solubilized in the aqueous compositions. Further, the materials can be made by combining the unoxidized acid with a peroxygen compound such as hydrogen peroxide and/or ozone to generate the peracid in situ prior to blending the peroxycarboxylic acid with other constituents. This is described in U.S. Pat. No. 5,122,538, incorporated by reference herein. The resulting composition can be characterized as follows:



Component	Exemplary Range (wt. %)	Exemplary Range (wt. %)	Exemplary Range (wt. %)
carboxylic acid	1-80	20-60	20-40
peroxycarboxylic acid	1-50	5-30	10-20
oxidizer	1-50	5-30	5-15

**[0042]** A carboxylic acid is an organic acid ( $R-COOH$ ) which contains an aliphatic group and one or more carboxyl groups. A carboxyl group is represented by  $-COOH$ , and is usually located at a terminal end of the acid. The aliphatic group can be a substituted or unsubstituted group. Common aliphatic substituents may include  $-OH$ ,  $-OR$ ,  $-NO_2$ , halogen, and other substituents common on these groups. An example of a simple carboxylic acid is acetic acid, which has the formula  $CH_3COOH$ . A peroxycarboxylic acid is a carboxylic acid which has been oxidized to contain a terminal  $-COOOH$  group. The term peroxy acid is often used to represent a peroxycarboxylic acid. An example of a simple peroxy acid is peroxyacetic acid, which has the formula  $CH_3COOOH$ .

**[0043]** The peroxycarboxylic acid can be formulated by combining a monocarboxylic acid, such as acetic acid, with an oxidizer such as hydrogen peroxide and/or ozone. The result of this combination is a reaction producing a peroxycarboxylic acid, such as peroxyacetic acid, and water. The reaction follows an equilibrium in accordance with the following equation:



**[0044]** wherein the  $pK_{eq}$  is 1.7.

**[0045]** The importance of the equilibrium results from the presence of hydrogen peroxide, the carboxylic acid and the peroxycarboxylic acid in the same composition at the same time. Because of this equilibrium, a mixture of carboxylic acid and peroxycarboxylic acid can be combined in water without adding hydrogen peroxide. If permitted to approach equilibrium, the mixture will evolve hydrogen peroxide. This combination provides enhanced sanitizing with none of the deleterious environmental or organoleptic effects of other sanitizing agents, additives, or compositions.

**[0046]** Carboxylic acids have the formula  $R-COOH$  wherein the R may represent any number of different groups including aliphatic groups, alicyclic groups, aromatic groups, heterocyclic groups, all of which may be saturated or unsaturated. Carboxylic acids also occur having one, two, three, or more carboxyl groups. Aliphatic groups can be further differentiated into three distinct classes of hydrocarbons. Alkanes (or paraffins) are saturated hydrocarbons. Alkenes (or olefins) are unsaturated hydrocarbons which contain one or more double bonds and alkynes (or acetylenes) are unsaturated hydrocarbons containing one or more highly reactive triple bonds.

**[0047]** Alicyclic groups can be further differentiated into three distinct classes of cyclic hydrocarbons. Cycloparaffins are saturated cyclic hydrocarbons. Cycloolefins are unsaturated cyclic hydrocarbons which contain one or more double bonds while cycloacetylenes are unsaturated cyclic hydrocarbons containing one or more highly reactive triple bonds. Aromatic groups are defined as possessing the unsaturated hydrocarbon ring structure representative of benzene. Heterocyclic groups are defined as 5 or 6 member ring structures wherein one or more of the ring atoms are not carbon. An

example is pyridine, which is essentially a benzene ring with one carbon atom replaced with a nitrogen atom.

**[0048]** Carboxylic acids have a tendency to acidify aqueous compositions in which they are present as the hydrogen atom of the carboxyl group is active. Moreover, the carboxylic acid constituent within the invention maintains the composition at an acidic pH. The composition of the invention can utilize carboxylic acids containing as many as 10 carbon atoms. Examples of suitable carboxylic acids include formic, acetic, propionic, butanoic, pentanoic, hexanoic, heptanoic, octanoic, nonanoic, decanoic, lactic, maleic, ascorbic, citric, hydroxyacetic, neopentanoic, neoheptanoic, oxalic, malonic, succinic, glutaric, adipic, pimelic and subric acid.

**[0049]** Carboxylic acids which are generally useful are those having one or two carboxyl groups where the R group is a primary alkyl chain having a length of  $C_2$  to  $C_{10}$ , preferably  $C_2$  to  $C_5$  and which are freely water soluble. The primary alkyl chain is that carbon chain of the molecule having the greatest length of carbon atoms and directly appending carboxyl functional groups. Especially useful are mono- and dihydroxy substituted carboxylic acids including alpha-hydroxy substituted carboxylic acid. A preferred carboxylic acid is acetic acid, which produces peroxyacetic acid to increase the sanitizing effectiveness of the materials.

**[0050]** An exemplary peroxycarboxylic acid composition that can be used according to the invention includes medium chain peroxycarboxylic compositions such as those containing peroxyoctanoic acid compositions. Exemplary medium chain peroxycarboxylic acid compositions that can be used include those described in U.S. Pat. No. 7,771,737 that was filed with the United States Patent and Trademark Office on Jan. 9, 2004, the entire disclosure of which is incorporated herein by reference.

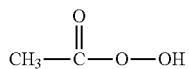
**[0051]** The oxidized carboxylic acid or peroxycarboxylic acid provides heightened antimicrobial efficacy when combined with hydrogen peroxide and the carboxylic acid in an equilibrium reaction mixture. Peroxycarboxylic acids generally have the formula  $R(CO_3H)_n$ , where R is an alkyl, arylalkyl, cycloalkyl, aromatic or heterocyclic group, and n is one or two and named by prefixing the parent acid with peroxy. The alkyl group can be a paraffinic hydrocarbon group which is derived from an alkane by removing one hydrogen from the formula. The hydrocarbon group may be either linear or branched, having up to 9 carbon atoms. Simple examples include methyl ( $CH_3$ ) and ethyl ( $CH_2CH_3$ ). An arylalkyl group contains both aliphatic and aromatic structures. A cycloalkyl group is defined as a cyclic alkyl group.

**[0052]** While peroxycarboxylic acids are not very stable, their stability generally increases with increasing molecular weight. Thermal decomposition of these acids may generally proceed by free radical and nonradical paths, by photodecomposition or radical-induced decomposition, or by the action of metal ions or complexes. Peroxycarboxylic acids may be made by the direct, acid catalyzed equilibrium action of hydrogen peroxide with the carboxylic acid, by autoxidation of aldehydes, or from acid chlorides, acid anhydrides, or carboxylic anhydrides with hydrogen or sodium peroxide.

**[0053]** Peroxycarboxylic acids useful in this invention include peroxyformic, peroxyacetic, peroxypropionic, peroxybutanoic, peroxy-pentanoic, peroxyhexanoic, peroxyheptanoic, peroxyoctanoic, peroxy-nonanoic, peroxydecanoic, peroxy-lactic, peroxy-maleic, peroxy-ascorbic, peroxy-hydroxyacetic, peroxy-oxalic, peroxy-malonic, peroxy-succinic, peroxy-glutaric, peroxy-adipic, peroxy-pimelic and peroxy-sub-

ric acid and mixtures thereof. These peroxy-carboxylic acids have been found to provide good antimicrobial action with good stability in aqueous streams.

**[0054]** Peroxyacetic acid is a peroxy-carboxylic acid with a structure as given the formula:



wherein the peroxy group, —O—O—, is considered a high energy bond. Generally, peroxyacetic acid is a liquid having an acrid odor and is freely soluble in water, alcohol, ether, and sulfuric acid. Peroxyacetic acid may be prepared through any number of means known to those of skill in the art including preparation from acetaldehyde and oxygen in the presence of cobalt acetate. A 50% solution of peroxyacetic acid may be obtained by combining acetic anhydride, hydrogen peroxide and sulfuric acid.

**[0055]** The treatment composition can provide antibacterial activity against a wide variety of microorganisms such as gram positive (for example, *Staphylococcus aureus*) and gram negative (for example, *Escherichia coli*) microorganisms, yeast, molds, bacterial spores, viruses, etc. When combined, the above peroxy acids can have enhanced activity compared to the low molecular weight peroxy acids alone.

#### Bleach Activators

**[0056]** In some embodiments, the antimicrobial activity and/or bleaching activity of the treatment compositions can be enhanced by the addition of a material which, when the composition is placed in use, reacts or somehow interacts to form an activated component. For example, in some embodiments, a peracid or a peracid salt can be formed. For example, in some embodiments, tetraacetylene diamine can be included within the composition to react with active oxygen and form a peracid or a peracid salt that acts as an antimicrobial and bleaching agent. Other examples of active oxygen activators include compounds that contain a carboxylic, nitrate, or ester moiety, or other such compounds known in the art. Additional exemplary activators include sodium nonanonyloxydenezene sulfonate (NOBS), acetyl caprolactone, and N-methyl morpholinium acetonitrile and salts thereof (such as Sokalan BMG from BASF).

#### Bleach Catalysts

**[0057]** In some embodiments, the bleaching activity of the treatment compositions can be enhanced by the addition of a material which, when the composition is placed in use, reacts or somehow interacts to form an activated component. For example, in some embodiments, transition metal catalysts, especially those with iron or manganese, may be used. Surrounding the metals are ligands that typically contain nitrogen or oxygen. Effective ligand structures include 1,4,7-trimethyl-1,4,7-triazacyclononane ( $\text{Me}_3\text{-TACN}$ ), 1,2-bis-(4,7-dimethyl-1,4,7-triazacyclonon-1-yl)-ethane ( $\text{Me}_4\text{-DTNE}$ ), N,N',N''-tris[salicylideneaminoethyl]amine (saltren), tetraamido macrocyclic ligand (TAML), bispyridyl pyrimidines and terpyridine ligands. Especially preferred transition metal catalysts are manganese containing compounds sold commercially under the names Dragon and Pegasus by Rahu Catalytics. In some embodiments instead of

adding a preformed catalyst, the ligands may optionally be prepared without metal. When added to the wash bath they may combine with trace metal ions naturally present in the wash water, or metal ions that have been intentionally added, to form a more active bleaching species in situ in the wash bath. Even in systems where there are no trace metal ions present in the water these ligands may bind to the metal ions present in stain for enhanced stain removal.

**[0058]** It is also known that organic compounds can act catalytically to improve bleaching performance without combining with metal ions present in either the wash water or the stain itself. Two general classes of such molecules are dioxiranes and oxaziridines. They are often formed in situ by oxidation of ketones and imines, respectively. Dihydroisoquinoline derivatives are one especially preferred class of molecules formed in this manner.

#### Adjuvants

**[0059]** The use of the treatment compositions can be followed by subsequent rinsing and/or finishing steps to impart desired benefits to the laundry or other surface being treated. Alternatively, many of the finishing components can be incorporated into the treatment compositions to impart the desired benefit during the treatment step. When used as a finishing composition, it is expected that certain components can be advantageously incorporated into the treatment compositions. In addition, it is expected that many of the components may provide a desired benefit even if the treatment composition is not used as a finishing composition. That is, certain components may provide an advantageous affect when used in the treatment compositions even when there may be additional steps subsequent to the treatment steps. Exemplary additional components include anti-redeposition agents, optical brighteners, sequestrants, builders, water conditioning agents, oil and water repellent agents, color fastness agents, starch/sizing agents, fabric softening agents, souring agents, iron controlling agents, and fragrances. The additional components are applied to the laundry during the washing step at a pH from about 5 to about 8 for an elapsed time of about 5 minutes.

**[0060]** Anti-redeposition agents can be used to facilitate sustained suspension of soils in a use solution and reduce the tendency of the soils to be redeposited onto a substrate from which they have been removed. Exemplary anti-redeposition agents include fatty acid amides, fluorocarbon surfactants, complex phosphate esters, styrene maleic anhydride copolymers, and cellulosic derivatives such as carboxymethyl cellulose, hydroxyethyl cellulose, hydroxypropyl cellulose, and the like. Specific exemplary anti-redeposition agents include styrene maleic anhydride copolymers, sodium tripolyphosphate, sodium carboxymethyl cellulose, polyvinylpyrrolidone, acrylic acid polymers, and maleic/olefinic copolymers.

**[0061]** Optical brightener, which can also be referred to as fluorescent whitening agent or fluorescent brightening agent, provides optical compensation for the yellow cast in fabric substrates. With optical brighteners yellowing is replaced by light emitted from optical brighteners present in the area commensurate in scope with yellow color. The violet to blue light supplied by the optical brighteners combines with other light reflected from the location to provide a substantially complete or enhanced bright white appearance. This additional light is produced by the brightener through fluorescence. Optical brighteners can absorb light in the ultraviolet

range (e.g., 275-400 nm) and can emit light in the ultraviolet blue spectrum (e.g., 400-500 nm).

**[0062]** Fluorescent compounds belonging to the optical brightener family are typically aromatic or aromatic heterocyclic materials often containing condensed ring system. An important feature of these compounds is the presence of an uninterrupted chain of conjugated double bonds associated with an aromatic ring. The number of such conjugated double bonds is dependent on substituents as well as the planarity of the fluorescent part of the molecule. Most brightener compounds are derivatives of stilbene or 4,4'-diamino stilbene, biphenyl, five membered heterocycles (triazoles, oxazoles, imidazoles, etc.) or six membered heterocycles (cumarins, naphthalamides, triazines, etc.). The choice of optical brighteners for use in detergent compositions will depend upon a number of factors, such as the type of detergent, the nature of other components present in the detergent composition, the temperature of the wash water, the degree of agitation, and the ratio of the material washed to the tub size. The brightener selection is also dependent upon the type of material to be cleaned, e.g., cottons, synthetics, etc. Since most laundry detergent products are used to clean a variety of fabrics, the detergent compositions should contain a mixture of brighteners which are effective for a variety of fabrics. It is of course necessary that the individual components of such a brightener mixture be compatible.

**[0063]** Optical brighteners useful in the present invention are known and commercially available. Commercial optical brighteners which may be useful in the present invention can be classified into subgroups, which include, but are not necessarily limited to, derivatives of stilbene, pyrazoline, coumarin, carboxylic acid, methinecyanines, dibenzothiophene-5,5-dioxide, azoles, 5- and 6-membered-ring heterocycles and other miscellaneous agents. Examples of these types of brighteners are disclosed in "The Production and Application of Fluorescent Brightening Agents", M. Zahradnik, Published by John Wiley & Sons, New York (1982), the disclosure of which is incorporated herein by reference.

**[0064]** Stilbene derivatives which may be useful in the present invention include, but are not necessarily limited to, derivatives of bis(triazinyl)amino-stilbene; bisacylamino derivatives of stilbene; triazole derivatives of stilbene; oxadiazole derivatives of stilbene; oxazole derivatives of stilbene; and styryl derivatives of stilbene. Preferred optical brighteners include stilbene derivatives.

**[0065]** The treatment compositions can include a sequestrant. In general, a sequestrant is a molecule capable of coordinating (i.e., binding) the metal ions commonly found in natural water to prevent the metal ions from interfering with the action of the other detergent ingredients of a cleaning composition. Some chelating/sequestering agents can also function as a threshold agent when included in an effective amount. For a further discussion of chelating agents/sequestrants, see Kirk-Othmer, Encyclopedia of Chemical Technology, Third Edition, volume 5, pages 339-366 and volume 23, pages 319-320.

**[0066]** A variety of sequestrants can be used including, for example, organic phosphonate, aminocarboxylic acid, condensed phosphate, inorganic builder, polymeric polycarboxylate, mixture thereof, or the like. Such sequestrants and builders are commercially available. Suitable condensed phosphates include sodium and potassium orthophosphate, sodium and potassium pyrophosphate, sodium and potassium tripolyphosphate, sodium hexametaphosphate, preferably of

tripolyphosphate. In an embodiment, the cleaning composition includes as a builder, chelator, or sequestrant a condensed phosphate, such as sodium tripolyphosphate. Polycarboxylates suitable for use as cleaning agents include, for example, polyacrylic acid, maleic/olefin copolymer, acrylic/maleic copolymer, polymethacrylic acid, acrylic acid-methacrylic acid copolymers, hydrolyzed polyacrylamide, hydrolyzed polymethacrylamide, hydrolyzed polyamide-methacrylamide copolymers, hydrolyzed polyacrylonitrile, hydrolyzed polymethacrylonitrile, hydrolyzed acrylonitrile-methacrylonitrile copolymers, polymaleic acid, polyfumaric acid, copolymers of acrylic and itaconic acid, and the like. Preferred polycarboxylates include polyacrylate.

**[0067]** In an embodiment, the treatment compositions include as sequestrant or builder condensed phosphate and polyacrylate, or another polymer, for example, sodium tripolyphosphate and polyacrylate. Sodium salts of condensed phosphates are preferred to the corresponding potassium salts.

**[0068]** The builder can include an organic phosphonate, such as an organic-phosphonic acid and alkali metal salts thereof. Some examples of suitable organic phosphonates include:

**[0069]** 1-hydroxyethane-1,1-diphosphonic acid:  $\text{CH}_3\text{C}(\text{OH})[\text{PO}(\text{OH})_2]_2$ ;

**[0070]** aminotri(methylenephosphonic acid):  $\text{N}[\text{CH}_2\text{PO}(\text{OH})_2]_3$ ;

**[0071]** aminotri(methylenephosphonate), sodium salt



**[0072]** 2-hydroxyethyliminobis(methylenephosphonic acid):  $\text{HOCH}_2\text{CH}_2\text{N}[\text{CH}_2\text{PO}(\text{OH})_2]_2$ ; diethylenetriaminopenta(methylenephosphonic acid):  $(\text{HO})_2\text{POCH}_2\text{N}[\text{CH}_2\text{CH}_2\text{N}[\text{CH}_2\text{PO}(\text{OH})_2]_2]_2$ ; diethylenetriaminopenta(methylenephosphonate), sodium salt:  $\text{C}_9\text{H}_{(28-x)}\text{N}_3\text{Na}_x\text{O}_{15}\text{P}_5$  ( $x=7$ ); hexamethylenediamine (tetramethylenephosphonate), potassium salt:  $\text{C}_{10}\text{H}_{(28-x)}\text{N}_2\text{K}_x\text{O}_{12}\text{P}_4$  ( $x=6$ );

**[0073]** bis(hexamethylene)triamine(pentamethylenephosphonic acid):  $(\text{HO})_2\text{POCH}_2\text{N}[(\text{CH}_2)_6\text{N}[\text{CH}_2\text{PO}(\text{OH})_2]_2]_2$ ; and

**[0074]** phosphorus acid  $\text{H}_3\text{PO}_3$ ; and other similar organic phosphonates, and mixtures thereof.

**[0075]** The sequestrant can be or include aminocarboxylic acid type sequestrant. Suitable aminocarboxylic acid type sequestrants include the acids or alkali metal salts thereof, e.g., amino acetates and salts thereof. Some examples include N-hydroxyethylaminodiacetic acid; hydroxyethylenediaminetetraacetic acid, nitrilotriacetic acid (NTA); methylglycinediacetic acid (MGDA); 2-hydroxyethyliminodiacetic acid (HEIDA); ethylenediaminetetraacetic acid (EDTA); N-hydroxyethyl-ethylenediaminetriacetic acid (HEDTA); diethylenetriaminopentaacetic acid (DTPA); and alanine-N, N-diacetic acid; and the like; and mixtures thereof.

**[0076]** Preferred aminocarboxylates include the sodium salt of EDTA, MGDA, and HEIDA.

**[0077]** An exemplary sequestrant or builder that can be used includes iminodisuccinic acid (IDS) and salt of iminodisuccinic acid. Such sequestrants are desirable because they

are generally considered to be more environmentally friendly compared with other sequestrants.

**[0078]** Exemplary oil and water repellent agents that can be used include fluoropolymers and hydrocarbon wax materials. It should be understood that the oil and water repellent agents are optional.

**[0079]** Exemplary color fastness agents that can be used include polyvinyl pyrrolidone and quaternary amines. It should be understood that the color fastness agents are optional.

**[0080]** The treatment compositions can include starch/sizing agents as optional components. Exemplary starch/sizing agents that can be used include polyvinyl acetates, corn starch, rice starch, and wheat starch.

**[0081]** The treatment compositions can include softening agents. Exemplary softening agents include quaternary ammonium compounds such as alkylated quaternary ammonium compounds, ring or cyclic quaternary ammonium compounds, aromatic quaternary ammonium compounds, diquaternary ammonium compounds, alkoxyalkylated quaternary ammonium compounds, amidoamine quaternary ammonium compounds, ester quaternary ammonium compounds, and mixtures thereof.

**[0082]** Exemplary alkylated quaternary ammonium compounds include ammonium compounds having an alkyl group containing between 6 and 24 carbon atoms. Exemplary alkylated quaternary ammonium compounds include monoalkyl trimethyl quaternary ammonium compounds, monomethyl trialkyl quaternary ammonium compounds, and dialkyl dimethyl quaternary ammonium compounds. Examples of the alkylated quaternary ammonium compounds are available commercially under the names Adogen™, Arosurf®, Variquat®, and Varisoft®. The alkyl group can be a C<sub>8</sub>-C<sub>22</sub> group or a C<sub>8</sub>-C<sub>18</sub> group or a C<sub>12</sub>-C<sub>22</sub> group that is aliphatic and saturated or unsaturated or straight or branched, an alkyl group, a benzyl group, an alkyl ether propyl group, hydrogenated-tallow group, coco group, stearyl group, palmityl group, and soya group. Exemplary ring or cyclic quaternary ammonium compounds include imidazolium quaternary ammonium compounds and are available under the name Varisoft®. Exemplary imidazolium quaternary ammonium compounds include methyl-1-hydr. tallow amido ethyl-2-hydr. tallow imidazolium-methyl sulfate, methyl-1-tallow amido ethyl-2-tallow imidazolium-methyl sulfate, methyl-1-oleyl amido ethyl-2-oleyl imidazolium-methyl sulfate, and 1-ethylene bis(2-tallow, 1-methyl, imidazolium-methyl sulfate). Exemplary aromatic quaternary ammonium compounds include those compounds that have at least one benzene ring in the structure. Exemplary aromatic quaternary ammonium compounds include dimethyl alkyl benzyl quaternary ammonium compounds, monomethyl dialkyl benzyl quaternary ammonium compounds, trimethyl benzyl quaternary ammonium compounds, and trialkyl benzyl quaternary ammonium compounds. The alkyl group can contain between about 6 and about 24 carbon atoms, and can contain between about 10 and about 18 carbon atoms, and can be a stearyl group or a hydrogenated tallow group. Exemplary aromatic quaternary ammonium compounds are available under the names Variquat® and Varisoft®. The aromatic quaternary ammonium compounds can include multiple benzyl groups. Diquaternary ammonium compounds include those compounds that have at least two quaternary ammonium groups. An exemplary diquaternary ammonium compound is N-tallow pentamethyl propane diammonium dichloride and

is available under the name Adogen 477. Exemplary alkoxyalkylated quaternary ammonium compounds include methyl-dialkylalkoxy alkyl quaternary ammonium compounds, trialkoxy alkyl quaternary ammonium compounds, trialkoxy methyl quaternary ammonium compounds, dimethyl alkoxy alkyl quaternary ammonium compounds, and trimethyl alkoxy quaternary ammonium compounds. The alkyl group can contain between about 6 and about 24 carbon atoms and the alkoxy groups can contain between about 1 and about 50 alkoxy groups units wherein each alkoxy unit contains between about 2 and about 3 carbon atoms. Exemplary alkoxyalkylated quaternary ammonium compounds are available under the names Variquat®, Varstat®, and Variquat®. Exemplary amidoamine quaternary ammonium compounds include diamidoamine quaternary ammonium compounds. Exemplary diamidoamine quaternary ammonium compounds are available under the name Varisoft®. Exemplary amidoamine quaternary ammonium compounds that can be used according to the invention are methyl-bis(tallow amidoethyl)-2-hydroxyethyl ammonium methyl sulfate, methyl bis(oleylamidoethyl)-2-hydroxyethyl ammonium methyl sulfate, and methyl bis(hydr.tallowamidoethyl)-2-hydroxyethyl ammonium methyl sulfate. Exemplary ester quaternary compounds are available under the name Stephantex™.

**[0083]** The quaternary ammonium compounds can include any counter ion that allows the component to be used in a manner that imparts fabric-softening properties. Exemplary counter ions include chloride, methyl sulfate, ethyl sulfate, and sulfate.

**[0084]** The treatment compositions can include souring agents to neutralize alkalinity. Exemplary souring agents include hydrofluorosilicic acid (HFS), citric acid, phosphoric acid, formic acid, and oxalic acid. It should be understood that the souring agent is optional and need not be present in the treatment compositions. When the treatment compositions include a souring agent, it can be included in an amount sufficient to provide neutralization.

#### Detergent Composition

**[0085]** In the current application, it is expected that a washing step that includes washing with a detergent composition will follow an antimicrobial treatment step. Bleaching may happen during the antimicrobial step. When it is preferred to use a bleach activator and/or bleach catalyst to improve stain removal that may happen either concurrently with the detergent or following the detergent. As such, the full laundry cycle includes treatments for antimicrobial effectiveness, cleaning and bleaching.

**[0086]** The detergent composition can be used with the bleaching treatment composition following the antimicrobial treatment composition according to the invention and is expected to provide a desired level of soil removal when used in a machine washing environment. The detergent composition can be a conventionally available detergent composition. Exemplary components in detergent compositions include a source of alkalinity, surfactants, builders, sequestrants, suds boosters or suds suppressors, anti-tarnish and anti-corrosion agents, soil suspending agents, soil release agents, pH adjusting agents, chelating agents, enzymes, enzyme-stabilizing agents, bleach activators, and solvents.

**[0087]** The source of alkalinity can be provided when it is desirable to increase the pH of the detergent use solution. Conditions for the removal of soil are often favorable at higher pH values. Exemplary sources of alkalinity include

alkali metal hydroxides, such as sodium hydroxide, potassium hydroxide, and mixtures thereof; alkali metal silicates such as sodium metal silicate; alkali metal carbonates, alkali metal bicarbonates, alkali metal sesquicarbonates, and alkali metal borates. Sodium hydroxide can be used in an aqueous solution and in a variety of solid forms in varying particle sizes. The carbonate and borate sources are typically used in place of alkali metal hydroxide when a lower pH is desired.

**[0088]** Useful anionic surfactants include the water soluble salts, such as the alkali metal, ammonium and alkylammonium salts, of organic sulfuric reaction products having in their molecular structure an alkyl group containing from about 10 to about 20 carbon atoms and a sulfonic acid or sulfuric acid ester group. (Included in the term "alkyl" is the alkyl portion of acyl groups.) Examples of this group of synthetic surfactants are the sodium and potassium alkyl sulfates, especially those obtained by sulfating the higher alcohols ( $C_{12}$ - $C_{18}$  carbon atoms) such as those produced by reducing the glycerides of tallow or coconut oil; and the sodium and potassium alkylbenzene sulfonates in which the alkyl group contains from about 10 to about 16 carbon atoms, in straight chain or branched chain configuration, e.g., see U.S. Pat. Nos. 2,220,099 and 2,477,383. Examples include linear straight chain alkylbenzene sulfonates in which the average number of carbon atoms in the alkyl group is from about 11 to 14, abbreviated as  $C_{11-14}$  LAS. Also, examples include mixtures of  $C_{10-16}$  (preferably  $C_{11-13}$ ) linear alkylbenzene sulfonates and  $C_{12-18}$  (preferably  $C_{14-16}$ ) alkyl sulfates, alkyl ether sulfates, alcohol ethoxylate sulfates, etc.

**[0089]** Other anionic surfactants herein are the sodium alkyl glyceryl ether sulfonates, especially those ethers of higher alcohols derived from tallow and coconut oil; sodium coconut oil fatty acid monoglyceride sulfonates and sulfates; sodium or potassium salts of alkyl ethylene oxide ether sulfates containing from about 1 to about 10 units of ethylene oxide per molecule and wherein the alkyl groups contain from about 8 to about 12 carbon atoms; and sodium or potassium salts of alkyl ethylene oxide ether sulfates containing about 1 to about 10 units of ethylene oxide per molecule and wherein the alkyl group contains from about 10 to about 20 carbon atoms.

**[0090]** Other useful anionic surfactants herein include the water soluble salts of esters of alpha-sulfonated fatty acids containing from about 6 to 20 carbon atoms in the fatty acid group and from about 1 to 10 carbon atoms in the ester group; water soluble salts of 2-acyloxyalkane-1-sulfonic acids containing from about 2 to 9 carbon atoms in the acyl group and from about 9 to about 23 carbon atoms in the alkane moiety; water soluble salts of olefin and paraffin sulfonates containing from about 12 to 20 carbon atoms; and beta-alkyloxy alkane sulfonates containing from about 1 to 3 carbon atoms in the alkyl group and from about 8 to 20 carbon atoms in the alkane moiety.

**[0091]** Also useful are surface active substances which are categorized as anionics because the charge on the hydrophobe is negative; or surfactants in which the hydrophobic section of the molecule carries no charge unless the pH is elevated to neutrality or above (e.g. carboxylic acids). Carboxylate, sulfonate, sulfate and phosphate are the polar (hydrophilic) solubilizing groups found in anionic surfactants. Of the cations (counterions) associated with these polar groups, sodium, lithium and potassium impart water solubility and are most preferred in compositions of the present invention.

**[0092]** Examples of suitable synthetic, water soluble anionic compounds are the alkali metal (such as sodium, lithium and potassium) salts or the alkyl mononuclear aromatic sulfonates such as the alkyl benzene sulfonates containing from about 5 to about 18 carbon atoms in the alkyl group in a straight or branched chain, e.g., the salts of alkyl benzene sulfonates or of alkyl naphthalene sulfonate, dialkyl naphthalene sulfonate and alkoxyated derivatives. Other anionic detergents are the olefin sulfonates, including long chain alkene sulfonates, long chain hydroxyalkane sulfonates or mixtures of alkenesulfonates and hydroxyalkane-sulfonates and alkylpoly (ethyleneoxy)ether sulfonates. Also included are the alkyl sulfates, alkyl poly (ethyleneoxy)ether sulfates and aromatic poly (ethyleneoxy) sulfates such as the sulfates or condensation products of ethylene oxide and nonyl phenol (usually having 1 to 6 oxyethylene groups per molecule).

**[0093]** Water soluble nonionic surfactants are also useful in the instant detergent granules. Such nonionic materials include compounds produced by the condensation of alkylene oxide groups (hydrophilic in nature) with an organic hydrophobic group or compound, which may be aliphatic or alkyl in nature. The length of the polyoxyalkylene group which is condensed with any particular hydrophobic group can be readily adjusted to yield a water soluble compound having the desired degree of balance between hydrophilic and hydrophobic elements.

**[0094]** Included are the water soluble and water dispersible condensation products of aliphatic alcohols containing from 8 to 22 carbon atoms, in either straight chain or branched configuration, with from 3 to 12 moles of ethylene oxide per mole of alcohol.

**[0095]** Nonionic surfactants are generally characterized by the presence of an organic hydrophobic group and an organic hydrophilic group and are typically produced by the condensation of an organic aliphatic, alkyl aromatic or polyoxyalkylene hydrophobic compound with a hydrophilic alkylene oxide moiety which in common practice is ethylene oxide or a polyhydration product thereof, polyethylene glycol. Practically any hydrophobic compound having a hydroxyl, carboxyl, amino, or amido group with a reactive hydrogen atom can be condensed with ethylene oxide, or its polyhydration adducts, or its mixtures with alkoxylenes such as propylene oxide to form a nonionic surface-active agent. The length of the hydrophilic polyoxyalkylene moiety which is condensed with any particular hydrophobic compound can be readily adjusted to yield a water dispersible or water soluble compound having the desired degree of balance between hydrophilic and hydrophobic properties.

**[0096]** Useful nonionic surfactants include block polyoxypropylene-polyoxyethylene polymeric compounds based upon propylene glycol, ethylene glycol, glycerol, trimethylpropane, and ethylenediamine as the initiator reactive hydrogen compound. Examples of polymeric compounds made from a sequential propoxylation and ethoxylation of initiator are commercially available under the trade name PLURONIC® manufactured by BASF Corp. PLURONIC® compounds are difunctional (two reactive hydrogens) compounds formed by condensing ethylene oxide with a hydrophobic base formed by the addition of propylene oxide to two hydroxyl groups of propylene glycol. This hydrophobic portion of the molecule weighs from about 1,000 to about 4,000. Ethylene oxide is then added to sandwich this hydrophobe between hydrophilic groups, controlled by length to consti-

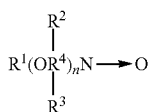
tute from about 10% by weight to about 80% by weight of the final molecule. TETRONIC® compounds are tetra-functional block copolymers derived from the sequential addition of propylene oxide and ethylene oxide to ethylenediamine. The molecular weight of the propylene oxide hydrotype ranges from about 500 to about 7,000; and, the hydrophile, ethylene oxide, is added to constitute from about 10% by weight to about 80% by weight of the molecule.

[0097] Also useful nonionic surfactants include the condensation products of one mole of alkyl phenol wherein the alkyl constituent, contains from about 8 to about 18 carbon atoms with from about 3 to about 50 moles of ethylene oxide. The alkyl group can, for example, be represented by diisobutylene, di-amyl, polymerized propylene, isoctyl, nonyl, and di-nonyl. Examples of commercial compounds of this chemistry are available on the market under the trade name IGEPAL® manufactured by Rhone-Poulenc and TRITON® manufactured by Union Carbide.

[0098] Likewise useful nonionic surfactants include condensation products of one mole of a saturated or unsaturated, straight or branched chain alcohol having from about 6 to about 24 carbon atoms with from about 3 to about 50 moles of ethylene oxide. The alcohol moiety can consist of mixtures of alcohols in the above delineated carbon range or it can consist of an alcohol having a specific number of carbon atoms within this range. Examples of like commercial surfactants are available under the trade name NEODOL® manufactured by Shell Chemical Co. and ALFONIC® manufactured by Vista Chemical Co.

[0099] Condensation products of one mole of saturated or unsaturated, straight or branched chain carboxylic acid having from about 8 to about 18 carbon atoms with from about 6 to about 50 moles of ethylene oxide. The acid moiety can consist of mixtures of acids in the above delineated carbon atoms range or it can consist of an acid having a specific number of carbon atoms within the range. Examples of commercial compounds of this chemistry are available on the market under the trade name NOPALCOL® manufactured by Henkel Corporation and LIPOPEG® manufactured by Lipo Chemicals, Inc. In addition to ethoxylated carboxylic acids, commonly called polyethylene glycol esters, other alkanolic acid esters formed by reaction with glycerides, glycerin, and polyhydric (saccharide or sorbitan/sorbitol) alcohols have application in this invention. All of these ester moieties have one or more reactive hydrogen sites on their molecule which can undergo further acylation or ethylene oxide (alkoxide) addition to control the hydrophilicity of these substances.

[0100] Tertiary amine oxides corresponding to the general formula:



can be used wherein the  $\rightarrow$  bond is a conventional representation of a semi-polar bond; and  $\text{R}^1$ ,  $\text{R}^2$ , and  $\text{R}^3$  may be aliphatic, aromatic, heterocyclic, alicyclic groups or a combination of such groups thereof. Generally, for amine oxides of detergent interest,  $\text{R}^1$  is an alkyl radical of from about 8 to about 24 carbon atoms;  $\text{R}^2$  and  $\text{R}^3$  are selected from the group consisting of alkyl or hydroxyalkyl of 1-3 carbon atoms and mixtures thereof;  $\text{R}^4$  is an alkylene or a hydroxyalkylene

group containing 2 to 3 carbon atoms; and  $n$  ranges from 0 to about 20. Useful water soluble amine oxide surfactants are selected from the coconut or tallow dimethyl amine oxides.

[0101] Semi-polar nonionic surfactants include water soluble amine oxides containing one alkyl moiety of from about 10 to 18 carbon atoms and two moieties selected from the group of alkyl and hydroxyalkyl moieties of from about 1 to about 3 carbon atoms; water soluble phosphine oxides containing one alkyl moiety of about 10 to 18 carbon atoms and two moieties selected from the group consisting of alkyl groups and hydroxyalkyl groups containing from about 1 to 3 carbon atoms; and water soluble sulfoxides containing one alkyl moiety of from about 10 to 18 carbon atoms and a moiety selected from the group consisting of alkyl and hydroxyalkyl moieties of from about 1 to 3 carbon atoms. Nonionic surfactants are of the formula  $\text{R}^1(\text{OC}_2\text{H}_4)_n\text{OH}$ , wherein  $\text{R}^1$  is a  $\text{C}_6$ - $\text{C}_{16}$  alkyl group and  $n$  is from 3 to about 80 can be used. Condensation products of  $\text{C}_6$ - $\text{C}_{15}$  alcohols with from about 5 to about 20 moles of ethylene oxide per mole of alcohol, e.g.,  $\text{C}_{12}$ - $\text{C}_{14}$  alcohol condensed with about 6.5 moles of ethylene oxide per mole of alcohol.

[0102] Amphoteric surfactants include derivatives of aliphatic or aliphatic derivatives of heterocyclic secondary and tertiary amines in which the aliphatic moiety can be straight chain or branched and wherein one of the aliphatic substituents contain from about 8 to 18 carbon atoms and at least one aliphatic substituent contains an anionic water solubilizing group.

[0103] Cationic surfactants can also be included in the present detergent compositions. Cationic surfactants include a wide variety of compounds characterized by one or more organic hydrophobic groups in the cation and generally by a quaternary nitrogen associated with an acid radical. Pentavalent nitrogen ring compounds are also considered quaternary nitrogen compounds. Halides, methyl sulfate and hydroxide are suitable. Tertiary amines can have characteristics similar to cationic surfactants at washing solution pH values less than about 8.5. A more complete disclosure of these and other cationic surfactants useful herein can be found in U.S. Pat. No. 4,228,044, Cambre, issued Oct. 14, 1980, incorporated herein by reference.

[0104] Useful cationic surfactants also include those described in U.S. Pat. No. 4,222,905, Cockrell, issued Sep. 16, 1980, and in U.S. Pat. No. 4,239,659, Murphy, issued Dec. 16, 1980, both incorporated herein by reference.

[0105] Additional ingredients that can be included in the detergent composition include those components described in U.S. Pat. No. 3,936,537, incorporated herein by reference.

[0106] Builders (or sequestrants) are employed to sequester hardness ions and to help adjust the pH of the laundering liquor. Such builders can be employed in concentrations up to about 85% by weight, preferably from about 0.5% to about 50% by weight, most preferably from about 10% to about 30% by weight, of the compositions herein to provide their builder and pH-controlling functions. The builders herein include any of the conventional inorganic and organic water soluble builder salts. Such builders can be, for example, water soluble salts of phosphates including tripolyphosphates, pyrophosphates, orthophosphates, higher polyphosphates, other carbonates, silicates, and organic polycarboxylates. Specific preferred examples of inorganic phosphate builders include sodium and potassium tripolyphosphates and pyrophosphates. Nonphosphorus-containing materials can also be selected for use herein as builders.

[0107] Specific examples of nonphosphorus, inorganic detergent builder ingredients include water soluble bicarbonate, and silicate salts. the alkali metal, e.g., sodium and potassium, bicarbonates, and silicates are particularly useful herein.

[0108] Water soluble, organic builders are also useful herein. For example, the alkali metal, polycarboxylates are useful in the present compositions. Specific examples of the polycarboxylate builder salts include sodium and potassium salts of ethylenediaminetetraacetic acid, nitrilotriacetic acid, oxydisuccinic acid, mellitic acid, benzene polycarboxylic acid, polyacrylic acid, polymaleic acid, iminodisuccinic acid, methylglycinediacetic acid, and 2-hydroxyethyliminodiacetic acid.

[0109] Other desirable polycarboxylate builders are the builders set forth in U.S. Pat. No. 3,308,067, incorporated herein by reference. Examples of such materials include the water soluble salts of homo- and copolymers of aliphatic carboxylic acids such as maleic acid, itaconic acid, mesaconic acid, fumaric acid, aconitic acid, citraconic acid, and methylenemalononic acid.

[0110] Other suitable polymeric polycarboxylates are the polyacetal carboxylates described in U.S. Pat. No. 4,144,226 and U.S. Pat. No. 4,246,495, both incorporated herein by reference. These polyacetal carboxylates can be prepared by bringing together under polymerization conditions an ester of glyoxylic acid and a polymerization initiator. The resulting polyacetal carboxylate ester is then attached to chemically stable end groups to stabilize the polyacetal carboxylate against rapid depolymerization alkaline solution, converted to the corresponding salt, and added to a surfactant.

[0111] Chelating agents are also described in U.S. Pat. No. 4,663,071, incorporated herein by reference. Suds modifiers are also optional ingredients and are described in U.S. Pat. Nos. 3,933,672, and 4,136,045, both incorporated herein by reference. The following examples were carried out to evaluate bleaching and antimicrobial properties of treatment compositions.

[0112] The invention has been shown and described herein in what is considered to be the most practical and preferred embodiment. The applicant recognizes, however, that departures may be made therefrom within the scope of the invention and that obvious modifications will occur to a person skilled in the art. The examples which follow are intended for purposes of illustration only and are not intended to limit the scope of the invention. All references cited herein are hereby incorporated in their entirety by reference.

## EXAMPLES

### Example 1

#### Improved Stain Removal Benefits from an Oxygen Antimicrobial Composition

[0113] Advacare 120 Sanitizer/Sour, a peroxyacetic acid based antimicrobial composition, commercially available by Ecolab USA, Inc. (St. Paul, Minn.) was used for this example. This commercially available antimicrobial composition is indicated for use at temperatures greater than or equal to 90 degrees Fahrenheit. Peroxyacetic acid also provides stain removal, but the performance is limited compared to the antimicrobial efficacy when the temperatures are lowered to around 90 degrees Fahrenheit. It is known that peroxygen antimicrobial compositions, including those with peracids

and/or hydrogen peroxide, can be used in conjunction with bleaching activators and/or catalysts, including transition metal catalysts, to improve the stain removal performance at lower temperatures. However, bleaching activators and/or catalysts act by consuming an oxygen source, which would lead to reduced antimicrobial efficacy if the antimicrobial composition and bleaching activator and/or catalyst are dosed simultaneously. Furthermore, some bleaching activators and/or catalysts are only effective at an alkaline pH, where the antimicrobial composition may not perform adequately. Therefore, in one embodiment, the use of an antimicrobial composition upfront in the wash cycle of a laundry process, prior to use of a detergent composition, later allows the remaining available oxygen of the antimicrobial composition to combine with a bleach activator and/or catalyst to provide optimal stain removal.

[0114] Example 1 Method of Testing The use of the present wash process for bleaching and detergency was evaluated using wash wheel performance data. The tests were run with a commercial 35 lb front loading washing machine (Huebsch HX35PVXU60001). The soil removal ability of the cleaning composition was determined by washing with artificially soiled fabric swatches. The soiled swatches were purchased from a manufacturer, specifically Test Fabrics, Inc. (West Pittston, Pa.). Polyester/cotton blend pillowcases (24 lb) were used as ballast.

[0115] A standard institutional and industrial wash process starts with an alkaline detergent composition, followed by a bleaching composition (oxygen or chlorine) and then several rinses. If the rinses are not adequate to remove all of the alkalinity and reduce the wash pH to a preferred range of about 5 to about 7, then an acidic sour may optionally be added. If the alkalinity present during washing is not adequately removed, the clean textiles may cause human skin irritation. Afterwards, an antimicrobial composition together with an acidic sour may optionally be applied. The antimicrobial composition may be optionally followed by an adjuvant, or other finishing chemical such as a softener, starch, fragrance, soil release polymer etc., but it is never followed by an alkaline detergent due to the possibility of skin irritation as mentioned above.

[0116] In Example 1, the wash formula was programmed to run for 15 minutes at 104 degrees Fahrenheit using 60 L of 5 grain synthetic soft water. In both instances the antimicrobial peracid composition was dosed immediately at the minimum indicated dose of 3 oz/cwt. In one example, the detergent, alkali and bleaching catalyst, which is commercially available under the brand Dragon A350 by Rahu Catalytics, were added together at the 5 minute mark. After the wash step, there were three subsequent rinse cycles and a final extract cycle. After completion of the entire cycle, the soil swatches were retrieved from the washer and allowed to air dry overnight at 70 degrees Fahrenheit.

[0117] To determine the percent (%) soil removal (SR) the reflectance of the fabric sample was measured on a spectrophotometer (Color Quest XE, Hunter Associated Laboratory). The "L" value is a direct reading supplied by the spectrophotometer. L generally is indicative of broad visible spectrum reflectance, where a value of 100% would be absolute white. The percent soil removal was calculated using the following formula:

$$SR = [(L_{final} - L_{initial}) / (96 - L_{initial})] * 100\%$$

[0118] Example 1 Test Results: The average stain removal data is shown below in Table 1 and the average soil removal data is shown below in Table 2. Table 1 shows the percent stain removal from an oxidizing antimicrobial peracid composition with and without a bleach catalyst composition.

TABLE 1

Stain	% Stain Removal	
	Antimicrobial Peracid Composition Only	Antimicrobial Peracid Composition with Bleach Catalyst
Tea	24.6	50.0
Coffee PC	31.0	51.4

[0119] Table 2 shows the percent soil removal from an oxidizing antimicrobial peracid composition with and without a bleach catalyst.

TABLE 2

Soil	% Soil Removal	
	Antimicrobial Peracid Composition Only	Antimicrobial Peracid Composition with Bleaching Catalyst
Dust Sebum PC	57.3	63.5
Lipstick	60.9	63.4
Makeup	31.9	30.3
Olive Oil PC	30.1	27.8

[0120] Bleachable stains, such as tea, wine, coffee, blueberry, curry, tomato, etc. are not physically removed from a textile; instead the color is lightened through reaction between an oxidizing chemical and the color producing chromophores in the stain molecule. Peroxyacetic acid is an oxidizing antimicrobial chemical with moderate stain removal at 40 degrees Celsius. As shown in Table 1, in the presence of a transition metal bleach catalyst, the stain removal is significantly increased versus the peracid antimicrobial alone.

[0121] In contrast to bleachable stains, for which the color is lightened though the stains remain, soils are physically removed during washing by some combination of chemistry (including, but not limited to, surfactants and alkali) and mechanical action during the wash process. Though some soils can contain oxidizable components, such as the dye in lipstick or other cosmetics, they are typically only minimally affected by the presence of the oxidizers. As shown in table 2, that was the case in Example 1, as expected. Of the four soils tested, two showed minimal increase and two showed minimal decline, demonstrating that there were no significant overall trends.

#### Example 2

##### Antimicrobial Benefits of an Oxygen Antimicrobial Composition and Bleaching Composition

[0122] In addition to its effectiveness as an oxidizing bleach, peroxyacetic acid is also known to have antimicrobial benefit. Advacare 120 Sanitizer/Sour is a commercially available antimicrobial composition from Ecolab, USA Inc. (St. Paul, Minn.) and is an EPA-registered sanitizer against the

organisms *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and methicillin-resistant *Staphylococcus aureus* (MRSA).

[0123] Example 2 Method of Testing: For the proposed wash process outlined above in Example 1 to be most beneficial, the stain removal should improve without sacrificing any of the antimicrobial efficacy. To test the antimicrobial activity, sterile 1"×2" cotton carriers were inoculated with *Staphylococcus aureus* ATCC 6538 and *Klebsiella pneumoniae* ATCC 4352. The carriers were dried and attached to a polyester napkin ("backer") with 5 carriers/backer. The backers were added to the machine along with the polyester/cotton fill, prior to the start of the wash load. After completion of the wash process, the backers were removed and processed without drying. Each carrier was placed in 10 mL of neutralizer, vortexed, serially diluted and then plated. For controls, 3 inoculated carriers and 2 uninoculated carriers were placed in 10 mL of phosphate buffered dilution water, vortexed, serially diluted and then plated.

[0124] Example 2 Test Results: For antimicrobial effectiveness, a >3 log reduction, i.e. greater than 99.9% organism kill, is considered to be the minimum threshold to demonstrate sanitizing efficacy. As shown in Table 3 below, for both organisms, *Staphylococcus aureus* ATCC 6538 and *Klebsiella pneumoniae* ATCC 4352, there was a >5 log reduction, thus demonstrating the antimicrobial activity is maintained, even in the presence of a bleaching composition, when the wash method described in the current invention is employed.

TABLE 3

Organism	Average Survivors (CFU/mL)	Log Reduction	Percent Reduction
<i>Staphylococcus aureus</i> ATCC 6538	<10	>5.34	>99.999
<i>Klebsiella pneumoniae</i> ATCC 4352	<10	>5.20	>99.999

#### Example 3

##### Chemical Residue, Benefits of an Antimicrobial Composition Containing Medium to Long Chain Fatty Acids

[0125] Turbo Oxysan is a commercially available bleach/disinfectant composition by Ecolab, USA Inc. (St. Paul, Minn.) which contains a blend of peracids, indicated for use in Europe at 40 degrees Celsius. One of the peracids is peroctanoic acid, which is present in equilibrium with the precursor octanoic acid. Both have the same eight carbon, non-polar hydrocarbon chain that makes the molecule minimally soluble in water and attracted to surfaces, including textiles or fabrics in a laundry application. If these molecules are not removed from the fabric by action of a detergent composition, or other stage in the wash process, they may leave a chemical residue on the linen.

[0126] In some cases, a chemical residue on linen can be preferred, such as fabric softeners containing molecules with quaternary ammonium ions ("quats") which require a thin layer of chemical residue to make the fibers feel smoother and prevent build up of static electricity. Another example is quats used for bacteriostatic activity, which leave a protective chemical layer to prevent future bacterial growth.



[0127] In other instances, a chemical residue is not preferred. Industrial and institutional laundry is conventionally washed at highly alkaline pH. If not all of the alkalinity is removed from the linen, the high pH might cause skin irritation. In another example, octanoic acid, as with other short or medium chain fatty acids, has an odor that is considered to be unpleasant. If octanoic acid residue is not removed from linen, then the unpleasant odor may remain on the fabric even after washing.

[0128] As such, in traditional washing methods, if an antimicrobial composition containing medium to long chain fatty acids that are only minimally water soluble is dosed in the final rinse step of a wash process then there is no remaining chemistry to remove any potential chemical residue.

[0129] Example 3 Method of Testing: Washwheel performance using the method described above in Example 1 was used to assess the effect of wash cycle placement of the antimicrobial active composition on chemical residue. The wash cycle was programmed to run for 16 minutes at 104 degrees Fahrenheit using 60 L of 5 grain synthetic soft water. After the wash, there was a 4 minute intermediate extract followed by a final rinse, which optionally included the antimicrobial active composition, and then a final extract. The same amount of antimicrobial active composition (1.8 g/L) was either dosed in the aforementioned final rinse step or added at the beginning of the wash cycle, with a detergent composition dosed after 8 minutes. The detergent composition used was Solid Surge Plus, a commercially available product from Ecolab, USA Inc. (St. Paul, Minn.).

[0130] Each wash load contained two untreated cotton terry swatches and each test condition was run in duplicate for a total of four swatches per condition. After completion of the wash cycle the swatches were analyzed for octanoic acid residue. Each swatch was placed in a 40 mL glass vial with 25 mL acetonitrile solvent and placed on a wrist action shaker for 15 minutes. After extraction, the solvent was analyzed for octanoic acid by reverse phase high performance liquid chromatography (HPLC) with UV detection at 210 nm. The limit of detection for octanoic acid residue was 52.5 ug/swatch.

[0131] Example 3 Acid Residue Test Results: As shown below in Table 4, when the antimicrobial active composition was dosed before the detergent composition there was no detectable octanoic acid residue. By contrast, there was 87.5 ug of octanoic acid residue on the terry towel swatches when the antimicrobial active composition was added to the wash cycle in the final rinse step. Therefore, it is preferred to dose the antimicrobial active composition upfront in the wash cycle of a laundry process prior to the addition of a detergent composition, rather than in the final rinse step, in order to prevent any undesired chemical residue.

TABLE 4

Wash Cycle Antimicrobial Active Composition Placement	Residual Octanoic Acid (ug/swatch)
Upfront	Not detected
Final Rinse Step	87.5

[0132] Example 3 Percent Stain Removal Test Results: While the placement of the antimicrobial active composition prior to the detergent composition prevents deposition of octanoic acid residue, for the washwheel placement to be effective the antimicrobial active composition must maintain stain removal and antimicrobial activity. As shown in Table 5

listed below, both the stain removal and antimicrobial activity were compared with the antimicrobial active composition placement in the final rinse step or upfront of the wash cycle prior to the detergent composition.

TABLE 5

Stain	Percent Stain Removal	
	Upfront	Final Rinse Step
Coffee PC	49.0	40.9
Curry	25.6	29.8
Tea	36.9	34.1

[0133] The results shown in Table 5 demonstrate that stain removal from an antimicrobial active composition is equivalent when dosed upfront prior to the detergent composition as when dosed in the final rinse step. When dosed upfront the stain removal on coffee and tea went up slightly. For the same dosing, the stain removal on curry went down slightly, though the two means were not significantly different. Overall there was no difference with stain removal from the antimicrobial active composition based on dose placement in the wash cycle.

[0134] Example 3—Antimicrobial Activity Method of Testing: In addition to stain removal, the antimicrobial activity of the antimicrobial active composition was also tested for the two wash wheel placements. When the antimicrobial active composition is dosed in the final rinse step, following an alkaline detergent composition, the use solution pH is approximately 6.5. When dosed prior to the detergent composition, the use solution pH is approximately 5.0. Therefore, the antimicrobial efficacy of the antimicrobial active composition was tested at each pH at 104 degrees Fahrenheit for 8 minutes. Additionally, when the antimicrobial active composition is dosed prior to the detergent composition, the detergent composition has not yet acted to remove the soil from the fabric. Therefore, when dosed upfront the antimicrobial active composition was also tested in presence of soil, in this case 5% Fetal Bovine Serum (FBS).

[0135] Fabric samples were inoculated with the test substances *Staphylococcus aureus* ATCC 6538 and *Klebsiella pneumoniae* ATCC 4352. The inoculated swatches were then dried. The samples were then secured in a laundrometer and agitated in wash water. The wash water was removed from the chamber of the laundrometer, and the wash water and fabric samples were evaluated for the reduction of the tested micro-organism population.

[0136] Example 3—Antimicrobial Activity Test Results: As shown below in Table 6, when dosed in the final rinse step with a use pH of 6.5, the antimicrobial active composition killed >99.9% of the bacteria tested (*Staphylococcus aureus* and *Klebsiella pneumoniae*), meeting the EPA criteria for sanitizing laundry antimicrobial compositions. When dosed prior to the detergent, the antimicrobial activity was the same, with the antimicrobial activity preserved, despite the difference in pH. Furthermore, there was no reduction in antimicrobial performance in the presence of organic soil (fetal bovine serum), demonstrating that efficacy could still be maintained in a laundry application even if the detergent composition has not yet removed the soil.

TABLE 6

Wash Cycle Placement	Use pH	Organism	Soil	Survivors in Wash Water (CFU/mL)	Average Reduction in Wash Water (%)	Average Survivors on Carriers (CFU/carrier)	Average Reduction in Carriers (%)
Final Rinse	6.5	<i>S. aureus</i>	—	<10	>99.929%	$<1.33 \times 10^1$	>99.999%
		<i>K. pneumoniae</i>	—	<10	>99.957%	$<2 \times 10^1$	>99.989%
Upfront	5	<i>S. aureus</i>	—	<10	>99.929%	<10	>99.999%
		<i>K. pneumoniae</i>	—	<10	>99.957%	<10	>99.995%
Upfront	5	<i>S. aureus</i>	Y	<10	>99.952%	<10	>99.999%
		<i>K. pneumoniae</i>	Y	<10	>99.999%	$<2.3 \times 10^1$	>99.997%

## Example 4

## Low Acid Antimicrobial Actives

[0137] Industrial and institutional laundry is typically done at highly alkaline pH, i.e. >pH 11. Conventionally, an antimicrobial active is most preferably used in the final rinse step after the majority of the alkalinity of the detergent composition has been rinsed out and the pH restored to near neutral. However, it has been proposed in the art to use the antimicrobial active immediately following the detergent composition and therefore prior to the final rinse step. If following a highly alkaline detergent composition, this approach can be effective if the antimicrobial composition contains a large amount of acid to neutralize the alkalinity which has not yet been rinsed out of the linen. If, however, the antimicrobial composition is not highly acidic, it will be unable to fully neutralize the alkalinity, and will therefore be ineffective.

[0138] Example 4—Composition for Testing: In the current example, two commercially available peracid antimicrobial composition were used, specifically Advacare 120 Sanitizer/Sour (Commercial Product A) and Turbo Oxysan (Commercial Product B) (both available from Ecolab USA, Inc. (St. Paul, Minn.)). Commercial Product A solely contains peroxyacetic acid and Commercial Product B contains a blend of peroxyacetic acid and peroctanoic acid. An experimental composition containing peroctanoic acid that is substantially free of peroxyacetic acid was also tested. The experimental composition is listed below in Table 7. After equilibrium the experimental composition was titrated to be 4.7% peroctanoic acid. The experimental composition listed below is currently protected by U.S. application Ser. No. 13/221,613, filed on Aug. 30, 2011.

TABLE 7

Raw Material	Amount (wt. %)
Octanoic Acid	4-20
Hydrogen Peroxide, 50%	30-50
Stabilizer	0.01-4
Solvent	0-10
Anionic Surfactant	10-40
Nonionic Surfactant	0-25
Hydrotrope	1-5

[0139] Table 8 listed below, shows the number of moles of acid per 100 grams of Commercial Products A, B and the Experimental Composition.

TABLE 8

Products	Number Moles of Acid/100 grams
Commercial Product A	0.731
Commercial Product B	0.250
Experimental Composition	0.100

[0140] As shown in Table 8 above, both of the commercially available products A and B have more moles of acid than the experimental composition, which has 2.5 times less than the next closest product, specifically Commercial Product B. Therefore, if the experimental composition is dosed immediately after the alkaline detergent composition it will be able to neutralize much less base. Peracids usually give better performance for both stain removal and antimicrobial activity close to the pKa (around pH 8) rather than at a high alkaline pH. If the antimicrobial composition does not have enough acidity it will not bring the overall pH down into the optimal region. All of the products in Table 8 are equilibrium peracids, which require an acid catalyst to help drive peracid formation and/or stabilization. The proposed wash process is even more preferred for preformed peracids, which are not at equilibrium and therefore do not require a strong acid catalyst to drive peracid formation and/or stabilization. An example of a preformed peracid that does not require a strong acid catalyst to maintain peracid stability is phthalimidoperhexanoic acid, or PAP, sold commercially by Solvay under the trade name Eureco. For example, other stabilization agents include boric acid and Beta cyclodextrin. With these stabilizing agents the product concentrate pH is typically about 4, rather than an equilibrium peracid which has a concentrate pH that is about 1 or lower. With no strong acid present in the composition it will have very little ability to lower the overall use solution pH following an alkaline detergent.

[0141] Oxidation-Reduction Potential (ORP): Oxidation-Reduction Potential is a measure of the tendency of a chemical species to acquire or donate electrons. An oxidizer will seek to acquire electrons and have a positive ORP (mV) value. A reducer will seek to donate electrons and have a negative ORP (mV) value. Each species has its own potential; the more positive the potential, the stronger the oxidizer and the more negative the potential the stronger the reducer. Typically, for an oxidizing species the capability for oxidative stain removal and/or antimicrobial activity is directly correlated with the ORP value.

[0142] To study the effectiveness of an antimicrobial composition when dosed after an alkaline detergent composition, the ORP and pH were measured as a function of oxidizer

concentration. A solution of Solid Surge Plus, a commercially available alkaline detergent from Ecolab USA, Inc. (St. Paul, Minn.) was made in deionized water (0.8 g/L). Into that solution, the experimental composition was added incrementally and the ORP and pH measured after each addition using an Ultrameter II 6P from Myron L Company.

[0143] The detergent composition used is a highly alkaline detergent, with a use solution pH around 12. If pH has no effect on ORP, the ORP would increase linearly with the concentration of the added oxidant. Rather, as illustrated in FIG. 3, the initial oxidizer addition leads to a very moderate increase in ORP, with a minor reduction in pH. However, around a pH of 10.5, an inflection point is reached. As the pH decreases very sharply, the ORP increases very sharply. Neither trend is linear with the initial data, thus demonstrating that ORP and pH are highly correlated. Therefore, if the oxidizer composition does not significantly reduce the pH the low ORP will be manifested by reduced stain removal and antimicrobial activity.

[0144] Example 4 Method of Testing: In the current example, the percent stain removal from the experimental composition was compared when dosed prior to the alkaline detergent composition and immediately following the alkaline detergent composition. The wash cycle described above in Example 3 was used. In one instance, the experimental composition was dosed immediately (1.5 g/L). After 8 minutes the water was drained, the washer refilled with fresh water and the detergent composition was added (0.8 g/L). In the other instance, the detergent composition was dosed first for 8 minutes, followed by the water drain process, the washer was refilled with fresh water and then the experimental composition was added. When immediately following the detergent composition, there is only enough acidity to reduce the pH to around 11. Based on the ORP data seen in FIG. 3 there is likely to be some stain removal, though non-optimal, at this high pH.

[0145] Example 4—Test Results: Table 9, shown below, demonstrates the percent stain removal for the low acid antimicrobial composition represented by the experimental composition, with different wash cycle placement.

TABLE 9

Stain	Percent Stain Removal	
	Prior to Detergent Composition, pH 7.2	After Detergent Composition, pH 11.0
Coffee PC	53.0	29.7
Curry	27.6	22.5
Tea	41.4	26.6

[0146] As shown in Table 9 above, the experimental composition does not have enough acidity to significantly reduce the pH when dosed after the detergent composition. This is manifested in stain removal values that are significantly lower than the same composition dosed prior to the detergent, with the use pH around 7.

[0147] As shown above in Table 8, Commercial Product B is a commercially available antimicrobial composition that contains more moles of acid, and therefore will be able to neutralize more alkalinity, than the experimental composition. If the more acidic product is more effective in lowering the overall use pH into the optimal range for both stain removal and antimicrobial activity, it will lead to better performance.

[0148] Table 10 shown below, demonstrates that percent stain removal from Commercial Product B, with different wash cycle placement.

TABLE 10

Stain	Percent Stain Removal	
	Prior to Detergent Composition, pH 5.1	After Detergent Composition, pH 8.9
Coffee PC	49.0	47.9
Curry	25.6	28.6
Tea	36.9	38.8

[0149] Due to the fact that Commercial Product B is more acidic than the experimental composition, it lowers the pH more, even though a detergent composition is not present. Whereas, the pH stayed neutral at 7.2 when the experimental composition was dosed prior to the detergent composition, when Commercial Product B was dosed in the same place during the wash cycle, the use pH was lowered to 5.1. This greater neutralization capability is also seen when dosed after the detergent composition, as the use pH with Commercial Product B is lowered to 8.9, versus 11.0 for the experimental composition. With that reduction, the oxidation potential is greatly increased, and it is expected that the stain removal would not suffer. In fact, with a more highly acidic antimicrobial composition, stain removal is equivalent whether dosed prior to the detergent composition or after.

[0150] Obviously, many modifications and variations of the invention as hereinbefore set forth can be made without departing from the spirit and scope thereof, and, therefore, only such limitations should be imposed as are indicated by the appended claims.

The following is claimed:

1. A method of sanitizing, disinfecting and bleaching laundry, the method comprising:
  - a. washing the laundry with an antimicrobial composition at a pH range from about 4 to about 9 in an industrial laundry washing machine for effective antimicrobial efficacy on the laundry; and thereafter
  - b. applying a detergent use solution at an alkaline pH in an industrial laundry washing machine for removal of soil from the laundry; and applying a bleach activator and/or catalyst composition to boost the bleaching component of the antimicrobial composition on the laundry; and
  - c. draining the antimicrobial composition, the detergent use solution and the bleach activator and/or catalyst composition from the laundry.
2. A method according to claim 1, wherein the antimicrobial composition is applied to the laundry in the industrial laundry washing machine for about 3-15 minutes.
3. A method according to claim 1, wherein the detergent use solution and the bleach activator and/or catalyst composition is applied to the laundry in the industrial laundry washing machine at a pH from about 9 to about 13 for about 3 to about 15 minutes.
4. A method according to claim 1, further comprising a step of rinsing the antimicrobial composition, the detergent use solution and the bleach activator and/or catalyst composition from the laundry.
5. A method according to claim 4, wherein the laundry is rinsed with water in the industrial laundry washing machine for about 1 to about 6 minutes.

6. A method according to claim 1, wherein an adjuvant use solution is applied to the laundry in the industrial laundry washing machine.

7. A method according to claim 6, wherein the adjuvant use solution comprises at least one of souring agents, fabric softening agents, starch, anti-wrinkle agents, sizing agents, colorfastness agents, oil and water repellent agents, water conditioning agents, iron controlling agents, water threshold agents, soil releasing agents, soil shielding agents, optical brightening agents, fragrances, and mixtures thereof.

8. A method according to claim 6, wherein the adjuvant use solution is applied to the laundry in the industrial laundry washing machine at a pH from about 5 to about 8 for about 1 to about 6 minutes.

9. A method according to claim 1, wherein the detergent use solution comprises an alkalinity source.

10. A method according to claim 10, wherein the alkalinity source comprises at least one of alkali metal hydroxide, alkali metal silicate, alkali metal carbonate or other base component.

11. A method according to claim 1, wherein the antimicrobial composition is selected from the group consisting of percarboxylic acids derived from medium to long chain fatty acids, as well as compositions containing low total acid actives and mixtures thereof.

12. A method according to claim 11, wherein the antimicrobial composition comprises at least one of a peroxy-carboxylic acid, an ester of peroxy-carboxylic acid, an alkaline salt of a peroxy-carboxylic acid, and adducts thereof.

13. A method according to claim 11, wherein the antimicrobial composition comprises at least one of  $C_1$ - $C_{10}$  aliphatic peroxy-carboxylic acid, salt of  $C_1$ - $C_{10}$  aliphatic peroxy-carboxylic acid, ester of  $C_1$ - $C_{10}$  aliphatic peroxy-carboxylic acid, and mixture thereof.

14. A method according to claim 11, wherein the antimicrobial composition comprises a peroxyoctanoic acid.

15. A method according to claim 11, wherein the antimicrobial composition comprises a peroxyacetic acid.

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