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(54) **AQUEOUS ACIDIC HARD SURFACE
CLEANING LIQUID COMPOSITION**

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(57) **ABSTRACT**

An aqueous acidic hard surface cleaning liquid composition containing amine oxide surfactant, citric acid and formic acid.

AQUEOUS ACIDIC HARD SURFACE CLEANING LIQUID COMPOSITION

FIELD OF THE INVENTION

[0001] The present invention relates to hard surface cleaning. The present invention provides hard surface cleaning compositions that are liquid. The compositions of the present invention are aqueous and acidic. The compositions of the present invention comprise amine oxide surfactant, citric acid, and formic acid. The compositions of the present invention have a pH in the range of from 1.9 to 2.5.

BACKGROUND OF THE INVENTION

[0002] Hard surface cleaning products need to provide several different benefits, including good anti-bacterial performance and good shine performance. The present invention seeks to provide an aqueous acidic hard surface cleaning liquid composition having both a good anti-bacterial performance and good shine performance.

[0003] Ingredients such as citric acid cannot be formulated in hard surface cleaning compositions at high levels without negatively affecting the shine performance. In addition, high levels of citric acid can lead to a tendency of the treated surface to feel sticky to touch.

[0004] In addition, ingredients such as amine oxide surfactant cannot be formulated in hard surface cleaning compositions at high levels without also negatively affecting the shine performance.

[0005] The present invention combines citric acid with formic acid as well as amine oxide surfactant to provide an aqueous acidic hard surface cleaning liquid composition having both a good anti-bacterial performance and good shine performance.

[0006] The presence of formic acid allows for lower levels of citric acid to be used. Without wishing to be bound by theory, the presence of formic acid maintains the reserve acidity of the product with lower total acid levels than can be achieved by citric acid alone. This in turn allows for lower levels of both citric acid and amine oxide surfactant to be used whilst still providing good product performance.

[0007] This combination of amine oxide surfactant levels, and the acid system (citric acid levels and formic acid levels) provides good shine performance and good anti-bacterial performance.

[0008] In addition, this level of anti-bacterial performance can be achieved without using quaternary ammonium compounds. This approach is more environmentally friendly.

SUMMARY OF THE INVENTION

[0009] The present invention provides an aqueous acidic hard surface cleaning liquid composition, wherein the composition comprises by weight of the composition:

[0010] (a) from 0.05 wt % to 2.5 wt % amine oxide surfactant;

[0011] (b) from 0.15 wt % to 4.00 wt % citric acid; and

[0012] (c) from 0.05 wt % to 0.5 wt % formic acid;

[0013] wherein the composition has a pH in the range of from 1.9 to 2.5.

[0014] The present invention also provides a cleaning kit for cleaning and sanitizing a hard surface, wherein the cleaning kit comprises:

[0015] (a) an aqueous acidic hard surface cleaning liquid composition of the present invention;

[0016] (b) a handle;

[0017] (c) a support head pivotally attached to said handle;

[0018] (d) a disposable cleaning substrate removably attached to the support head; and

[0019] (e) a liquid delivery system for providing the cleaning liquid composition (a) to a surface to be cleaned and sanitized.

DETAILED DESCRIPTION OF THE INVENTION

Aqueous Acidic Hard Surface Cleaning Liquid Composition

[0020] The aqueous acidic hard surface cleaning liquid composition comprises by weight of the composition:

[0021] (a) from 0.05 wt % to 2.5 wt % amine oxide surfactant;

[0022] (b) from 0.15 wt % to 4.00 wt % citric acid; and

[0023] (c) from 0.05 wt % to 0.5 wt % formic acid;

[0024] wherein the composition has a pH in the range of from 1.9 to 2.5.

[0025] Preferably, the composition comprises, by weight of the composition:

[0026] (a) from 0.175 wt % to 3.0 wt % citric acid; and

[0027] (b) from 0.050 wt % to 0.5 wt % formic acid,

[0028] wherein the weight ratio of citric acid to formic acid is in the range of from 60:1 to 2.0:1.

[0029] Preferably, the composition comprises, by weight of the composition:

[0030] (a) from 0.5 wt % to 1.5 wt % citric acid; and

[0031] (b) from 0.050 wt % to 0.35 wt % formic acid,

[0032] wherein the weight ratio of citric acid to formic acid is in the range of from 30:1 to 3.0:1.

[0033] The composition may further comprise, by weight of the composition, from 0.05 wt % to 0.8 wt % glycolic acid, preferably from 0.1 wt % to 0.4 wt % glycolic acid.

[0034] Preferably, the composition comprises, by weight of the composition, from 0.08 wt % to 0.45 wt % amine oxide surfactant.

[0035] Any suitable amine oxide surfactant can be used. Preferably, the amine oxide surfactant is a C₁₂-C₁₄ amine oxide surfactant.

[0036] The composition may further comprise, by weight of the composition, from 0.1 wt % to 1.0 wt % ether alcohol solvent. Any suitable ether alcohol solvent can be used. Preferably, the ether alcohol solvent is selected from dipropylene glycol n-butyl ether, propylene glycol mono-butyl ether, -propylene glycol phenyl ether, and any combination thereof.

[0037] Preferably, the composition has a reserve acidity of at least 0.15 g NaOH per 100 g product measured at 25° C.

[0038] Preferably the composition has a reserve acidity per total acid level of at least 0.28 g NaOH per 100 g of product per total weight percent acid measured at 25° C.

[0039] Typically, the composition further comprises one or more of the following ingredients selected from perfume, pH stabilizer, dye, antifoam agent, polymer, additional surfactant, preservative, chelant, and any combination thereof.

[0040] Typically, the composition comprises, by weight of the composition, from 90 wt % to 99.65 wt % water.

[0041] Preferably, the composition comprises, by weight of the composition:

[0042] (a) from 0.08 wt % to 0.3 wt % C₁₂-C₁₄ amine oxide surfactant;

[0043] (b) from 0.5 wt % to 1.5 wt % citric acid;

[0044] (c) from 0.1 wt % to 0.3 wt % formic acid, and

[0045] (d) from 0.1 wt % to 0.7 wt % glycol ether solvent,

[0046] wherein the pH of the liquid cleaning composition is from 1.9 to 2.5.

[0047] The composition is formulated as a liquid composition. A preferred composition herein is an aqueous composition and therefore, preferably comprises water more preferably in an amount of from about 50% to about 99%, even more preferably of from about 60% to about 98% and most preferably about 70% to about 97% by weight of the total composition.

[0048] The solids content of the composition, at usage levels, is generally low, preferably from about 0.01 wt % to about 4.0 wt %, or from above 0.03 wt % to 4.0 wt %, more preferably from about 0.05 wt % to about 3.0 wt %, most preferably from about 0.10 wt % to about 2.0 wt %. Those skilled in the art will recognize that the aqueous compositions of the present invention can be made in the form of about 5×, about 10×, or even higher concentrates as desired, and then diluted prior use. This is expected particularly when the aqueous composition is sold as a liquid intended to be diluted in a bucket or other receptacle. The making of concentrated solutions can also be beneficial if the aqueous composition must be transported.

Amine Oxide Surfactant

[0049] Suitable amine oxide surfactants include: $R_1R_2R_3NO$ wherein each of R_1 , R_2 and R_3 is independently a saturated or unsaturated, substituted or unsubstituted, linear or branched hydrocarbon chain having from 1 to 30 carbon atoms. Preferred amine oxide surfactants are amine oxides having the following formula: $R_1R_2R_3NO$ wherein R_1 is a hydrocarbon chain comprising from 1 to 30 carbon atoms, preferably from 6 to 20, more preferably from 8 to 16 and wherein R_2 and R_3 are independently saturated or unsaturated, substituted or unsubstituted, linear or branched hydrocarbon chains comprising from 1 to 4 carbon atoms, preferably from 1 to 3 carbon atoms, and more preferably are methyl groups. R_1 may be a saturated or unsaturated, substituted or unsubstituted linear or branched hydrocarbon chain.

[0050] Highly preferred amine oxides are C_8 dimethyl amine oxide, C_{10} dimethyl amine oxide, C_{12} - C_{14} dimethyl amine oxide, and C_{14} dimethyl amine oxide. C_8 dimethyl amine oxide is commercially available under the trade name Genaminox® OC from Clariant; C_{10} dimethyl amine oxide is commercially available under the trade name Genaminox® K-10 from Clariant; C_{12} - C_{14} dimethyl amine oxide is commercially available under the trade name Genaminox® LA from Clariant and of Empigen OB from Huntsman; C_{14} amine oxide is commercially available under the trade name of Empigen OH 25 from Huntsman. Other suitable amine oxide surfactants are cocoyldiethoxy amine oxide available under the trade name of genaminox CHE from Clariant, and cocamydopropyl amine oxide is commercially available under the trade name of empigen OS/A from Huntsman. Particularly preferred are C_{12} - C_{14} dimethyl amine oxide surfactants.

Optional Ingredients

[0051] The composition can incorporate additional optional ingredients in addition to the essential ingredients

required by the present invention. Suitable additional ingredients include surfactant, solvents and hydrotropes. The liquid composition may comprise a variety of other optional ingredients depending on the technical benefit aimed for and the surface treated. Suitable optional ingredients for use herein include perfume, pH stabilizer, dye, antifoam agent, polymer, additional surfactant, preservative, chelant, and any combination thereof.

Surfactant

[0052] Additional surfactants can be non-ionic, anionic, cationic, zwitterionic or amphoteric, and mixtures thereof. The required surfactant is defined as any material with a hydrophobic component consisting of a hydrocarbon moiety with between about 6 carbon atoms and about 20 carbon atoms, and a hydrophilic head group. The purpose of the surfactant is improved wetting of the hard surfaces to be treated. The wetting properties of the surfactant are essential to the compositions of the invention. The hydrophobic tail of the surfactant can be linear or branched, aliphatic aromatic. The hydrophilic head group can consist of any group such that provides wetting properties. Said surfactant may be present in the compositions according to the present invention in amounts of from about 0.01% to about 15%, preferably of from about 0.01% to about 10%, and more preferably of from about 0.02% to about 7.5% by weight of the total composition. At actual product use levels, the additional surfactants are typically present at levels from about 0.01% to about 1.5%, more preferably from about 0.01% to about 1%, and more preferably of from about 0.03% to about 0.75% by weight of the total composition.

[0053] More specifically, groups of non-ionic surfactants that can be used in the context of the following invention are as follows:

[0054] (i) The polyethylene oxide condensates of alkyl phenols, e.g., the condensation products of alkyl phenols having an alkyl group containing from about 6 to about 12 carbon atoms in either a straight chain or branched chain configuration, with ethylene oxide, the said ethylene oxide being present in amounts equal to about 10 to about 25 moles of ethylene oxide per mole of alkyl phenol. The alkyl substituent in such compounds may be derived from polymerized propylene, diisobutylene, octane, and nonane.

[0055] (ii) Those derived from the condensation of ethylene oxide with the product resulting from the reaction of propylene oxide and ethylene diamine products, which may be varied, in composition depending upon the balance between the hydrophobic and hydrophilic elements, which is desired. Examples are to increase the water-solubility of the molecule as a whole and the liquid character of the products is retained up to the point where polyoxyethylene content is about 50% of the total weight of the condensation product; compounds containing from about 40% to about 80% polyoxyethylene by weight and having a molecular weight of from about 5000 to about 11000 resulting from the reaction of ethylene oxide groups with a hydrophobic base constituted of the reaction product of ethylene diamine and excess propylene oxide, said base having a molecular weight of the order of about 2500 to about 3000.

[0056] (iii) The condensation product of aliphatic alcohols having from about 6 to about 18 carbon atoms, in

either straight chain or branched chain configuration, with ethylene oxide, propylene oxide, butylene oxide, and mixtures thereof, e.g., a coconut alcohol ethylene oxide condensate having from about 3 to about 15 moles of ethylene oxide per mole of coconut alcohol, the coconut alcohol fraction having from about 10 to about 14 carbon atoms; such materials are commonly known as 'alkyl alkoxyates' or 'alcohol alkoxyates'. In some cases, an alkyl ethoxyates can have capping groups, meaning that they have the structure $R_1-(EO)_xR_2$, where R_1 is a C_6 - C_{18} linear or branched moiety, x is from about 1 to about 15 and R_2 , the capping group, is a about C_1 to about C_8 hydrocarbyl moiety. Suitable branched alkoxyated alcohol may be selected from the group consisting of: C_4 - C_{10} alkyl branched alkoxyated alcohols, and mixtures thereof. The branched alkoxyated alcohol can be derived from the alkoxylation of C_4 - C_{10} alkyl branched alcohols selected from the group consisting of: C_4 - C_{10} primary mono-alcohols having one or more C_1 - C_4 branching groups. By C_4 - C_{10} primary mono-alcohol, it is meant that the main chain of the primary mono-alcohol has a total of from 4 to 10 carbon atoms. The C_4 - C_{10} primary mono-alcohol can be selected from the group consisting of: methyl butanol, ethyl butanol, methyl pentanol, ethyl pentanol, methyl hexanol, ethyl hexanol, propyl hexanol, dimethyl hexanol, trimethyl hexanol, methyl heptanol, ethyl heptanol, propyl heptanol, dimethyl heptanol, trimethyl heptanol, methyl octanol, ethyl octanol, propyl octanol, butyl octanol, dimethyl octanol, trimethyl octanol, methyl nonanol, ethyl nonanol, propyl nonanol, butyl nonanol, dimethyl nonanol, trimethyl nonanol and mixtures thereof. The C_4 - C_{10} primary mono-alcohol can be selected from the group consisting of: ethyl hexanol, propyl hexanol, ethyl heptanol, propyl heptanol, ethyl octanol, propyl octanol, butyl octanol, ethyl nonanol, propyl nonanol, butyl nonanol, and mixtures thereof. Preferably the C_4 - C_{10} primary mono-alcohol is selected from the group consisting of: ethyl hexanol, propyl hexanol, ethyl heptanol, propyl heptanol, and mixtures thereof. The C_4 - C_{10} primary mono-alcohol is most preferably ethyl hexanol, and propyl heptanol. In the branched alkoxyated alcohol, the one or more C_1 - C_4 branching group can be substituted into the C_4 - C_{10} primary mono-alcohol at a C1 to C3 position, preferably at the C1 to C2 position, more preferably at the C2 position, as measured from the hydroxyl group of the starting alcohol.

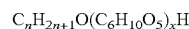
[0057] The branched alkoxyated alcohol can comprise from 1 to 14, preferably from 2 to 7, more preferably from 4 to 6 ethoxyate units, and optionally from 1 to 9, preferably from 2 to 7, more preferably from 4 to 6 of propoxyate units.

[0058] The branched alkoxyated alcohol is preferably 2-ethyl hexan-1-ol ethoxyated to a degree of from 4 to 6, and propoxyated to a degree of from 4 to 6, more preferably, the alcohol is first propoxyated and then ethoxyated. Another preferred branched alkoxyated alcohols are 2-alkyl-1-alkanols such as alkoxyated C_{10} guerbet alcohols with 1 to 14, preferably from 2 to 7, more preferably from 3 to 6 ethoxyate units.

[0059] Non-limiting examples of suitable branched alkoxyated alcohols are, for instance, Ecosurf®

EH3, EH6, and EH9, commercially available from DOW, and Lutensol XP alkoxyated Guerbet alcohols & Lutensol XL ethoxyated Guerbet alcohols available from BASF.

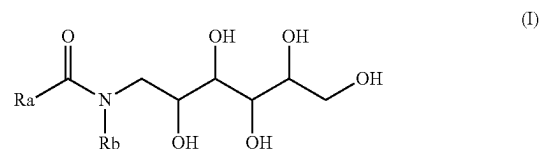
[0060] Other suitable surfactants include alkyl polyglucosides. Alkyl polyglucosides are biodegradable nonionic surfactants. Suitable alkyl polyglucosides can have the general formula:



[0061] wherein n is preferably from 8 to 16, more preferably 8 to 14, and x is at least 1.

[0062] Examples of suitable alkyl polyglucoside surfactants are the TRITON™ alkyl polyglucosides from Dow; Agnique PG, Disponil APG and Glucopon alkyl polyglucosides from BASF. Preferred alkyl polyglucoside surfactants are those where n is 8 to 12, more preferably 8 to 10, such as for example Glucopon 215 UP from BASF.

[0063] Other suitable surfactants are alkyl glucamide surfactants. Glucamide surfactants are non-ionic surfactants in which the hydrophilic moiety (an amino-sugar derivative) and the hydrophobic moiety (a fatty acid) are linked via amide bonds. Particularly preferred alkyl glucamide surfactants are N-alkyl-N-acylglucamides of the formula (I):



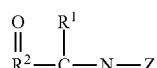
[0064] wherein R_a is a linear or branched, saturated or unsaturated hydrocarbyl group having 6 to 22 carbon atoms, and R_b is a C_1 - C_4 alkyl radical. Particularly preferably, R_b in formula (I) is a methyl radical.

[0065] Non-limiting examples of suitable glucamide surfactants are: N-octanoyl-N-methylglucamide, N-nonanoyl-N-methylglucamide, N-decanoyl-N-methylglucamide, N-dodecanoyl-N-methylglucamide, N-cocoyl-N-methylglucamide (available under the trade name of GlucoPure Foam by Clariant), N-lauroyl/myristoyl-N-methylglucamide (available under the trade name of GlucoPure Deg by Clariant), and N-octanoyl/decanoyl-N-methylglucamine (available under the trade name of GlucoPure Wet by Clariant).

[0066] Although not preferred, the condensation products of ethylene oxide with a hydrophobic base formed by the condensation of propylene oxide with propylene glycol are also suitable for use herein. The hydrophobic portion of these compounds will preferably have a molecular weight of from about 1500 to about 1800 and will exhibit water insolubility. The addition of polyoxyethylene moieties to this hydrophobic portion tends to increase the water solubility of the molecule as a whole, and the liquid character of the product is retained up to the point where the polyoxyethylene content is about 50% of the total weight of the condensation product, which corresponds to condensation with up to about 40 moles of ethylene oxide. Examples of compounds of this type include certain of the commercially available Pluronic® surfactants, marketed by BASF. Chemically, such surfactants have the structure $(EO)_x(PO)_y(EO)_z$ or $(PO)_x(EO)_y(PO)_z$ wherein x , y , and z are from about 1 to

about 100, preferably about 3 to about 50. Pluronic® surfactants known to be good wetting surfactants are more preferred. A description of the Pluronic® surfactants, and properties thereof, including wetting properties, can be found in the brochure entitled BASF Performance Chemicals Plutonic® & Tetronic® Surfactants”, available from BASF.

[0067] Other non-ionic surfactants, though not preferred, for use herein include polyhydroxy fatty acid amides of the structural formula:



[0068] wherein: R¹ is H, C1-C4 hydrocarbyl, 2-hydroxy ethyl, 2-hydroxypropyl, or a mixture thereof, preferably C₁-C₄ alkyl, more preferably C1 or C2 alkyl, most preferably C1 alkyl (i.e., methyl); and R² is a C5-C31 hydrocarbyl, preferably straight chain C₇-C₁₉ alkyl or alkenyl, more preferably straight chain C₉-C₁₇ alkyl or alkenyl, most preferably straight chain C₁₁-C₁₇ alkyl or alkenyl, or mixtures thereof; and Z is a polyhydroxy-hydrocarbyl having a linear hydrocarbyl chain with at least about 3 hydroxyls directly connected to the chain, or an alkoxyated derivative (preferably ethoxylated or propoxylated) thereof. Z preferably will be derived from a reducing sugar in a reductive amination reaction; more preferably Z is a glycyl. Suitable reducing sugars include glucose, fructose, maltose, lactose, galactose, mannose, and xylose. As raw materials, high dextrose corn syrup can be utilised as well as the individual sugars listed above. These corn syrups may yield a mix of sugar components for Z. It should be understood that it is by no means intended to exclude other suitable raw materials. Z preferably will be selected from the group consisting of —CH₂—(CHOH)_n—CH₂OH, —CH(CH₂OH)—(CHOH)_{n-1}—CH₂OH, —CH₂—(CHOH)₂(CHOR')(CHOH)—CH₂OH, where n is an integer from about 3 to about 5, inclusive, and R' is H or a cyclic or aliphatic monosaccharide, and alkoxyated derivatives thereof. Most preferred are glycyls wherein n is 4, particularly —CH₂—(CHOH)₄—CH₂OH.

[0069] In Formula (I), R¹ can be, for example, N-methyl, N-ethyl, N-propyl, N-isopropyl, N-butyl, N-2-hydroxy ethyl, or N-2-hydroxy propyl, R²—CO—N< can be, for example, cocamide, stearamide, oleamide, lauramide, myristamide, capricamide, palmitamide, tallowamide, etc., Z can be 1-deoxyglucityl, 2-deoxyfructityl, 1-deoxymaltityl, 1-deoxylactityl, 1-deoxygalactityl, 1-deoxymannityl, 1-deoxymaltotriosityl, etc.

[0070] Another type of suitable non-ionic surfactants for use herein are the 2-alkyl alkanols having an alkyl chain comprising from about 6 to about 16, preferably from about 7 to about 13, more preferably from about 8 to about 12, most preferably from about 8 to about 10 carbon atoms and a terminal hydroxy group, said alkyl chain being substituted in the α position (i.e., position number 2) by an alkyl chain comprising from about 1 to about 10, preferably from about 2 to about 8 and more preferably about 4 to about 6 carbon atoms.

[0071] Such suitable compounds are commercially available, for instance, as the Isofol® series such as Isofol® 12 (2-butyl octanol) or Isofol® 16 (2-hexyl decanol) commercially available from Condea.

[0072] A detailed listing of suitable non-ionic surfactants useful in this invention can be found in U.S. Pat. No. 4,557,853, Collins, issued Dec. 10, 1985.

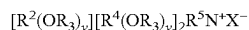
[0073] Anionic surfactants are not preferred, but can also be used in the present invention. Suitable anionic surfactants for use herein include alkali metal (e.g., sodium or potassium) fatty acids, or soaps thereof, containing from about 8 to about 24, preferably from about 10 to about 20 carbon atoms, linear or branched C₆-C₁₆ alcohols, C₆-C₁₂ alkyl sulfonates, C₆-C₁₈ alkyl sulfates 2-ethyl-1-hexyl sulfosuccinate, C₆-C₁₆ alkyl carboxylates, C₆-C₁₈ alkyl ethoxy sulfates.

[0074] The fatty acids including those used in making the soaps can be obtained from natural sources such as, for instance, plant or animal-derived glycerides (e.g., palm oil, coconut oil, babassu oil, soybean oil, castor oil, tallow, whale oil, fish oil, tallow, grease, lard and mixtures thereof). The fatty acids can also be synthetically prepared (e.g., by oxidation of petroleum stocks or by the Fischer-Tropsch process). Alkali metal soaps can be made by direct saponification of fats and oils or by the neutralization of the free fatty acids which are prepared in a separate manufacturing process. Particularly useful are the sodium and potassium salts of the mixtures of fatty acids derived from coconut oil and tallow, i.e., sodium and potassium tallow and coconut soaps.

[0075] Other suitable anionic surfactants for use herein include water-soluble salts, particularly the alkali metal salts, of organic sulfuric reaction products having in the molecular structure an alkyl radical containing from about 8 to about 22 carbon atoms and a radical selected from the group consisting of sulfonic acid and sulfuric acid ester radicals. Important examples of these synthetic detergents are the sodium, ammonium or potassium alkyl sulfates, especially those obtained by sulfating the higher alcohols produced by reducing the glycerides of tallow or coconut oil; sodium or potassium alkyl benzene sulfonates, in which the alkyl group contains from about 9 to about 15 carbon atoms, especially those of the types described in U.S. Pat. Nos. 2,220,099 and 2,477,383; sodium alkyl glyceryl ether sulfonates, especially those ethers of the higher alcohols derived from tallow and coconut oil; sodium coconut oil fatty acid monoglyceride sulfates and sulfonates; sodium or potassium salts of sulfuric acid esters of the reaction product of one mole of a higher fatty alcohol (e.g., tallow or coconut oil alcohols) and about three moles of ethylene oxide; sodium or potassium salts of alkyl phenol ethylene oxide ether sulfates with about four units of ethylene oxide per molecule and in which the alkyl radicals contain about 9 carbon atoms; sodium or potassium salts of alkyl ethylene oxide ether sulfates with about four units of ethylene oxide per molecule and in which the alkyl radicals contain 6 to 18 carbon atoms; the reaction product of fatty acids esterified with isothionic acid and neutralized with sodium hydroxide where, for example, the fatty acids are derived from coconut oil; sodium or potassium salts of fatty acid amide of a methyl taurine in which the fatty acids, for example, are derived from coconut oil; and others known in the art, a number being specifically set forth in U.S. Pat. Nos. 2,486,921, 2,486,922 and 2,396,278. Other suitable anionic surfactants

include C₆-C₁₈ alkyl ethoxy carboxylates, C₈-C₁₈ methyl ester sulfonates, 2-ethyl-1-hexyl sulfosuccinamate, 2-ethyl-1-hexyl sulfosuccinate and the like.

[0076] Cationic surfactants are not preferred but can be used at low levels in compositions of the present invention are those having a long-chain hydrocarbyl group. Examples of such cationic surfactants include the ammonium surfactants such as alkyldimethylammonium halogenides, and those surfactants having the formula:



[0077] wherein R² is an alkyl or alkyl benzyl group having from about 8 to about 18 carbon atoms in the alkyl chain, each R³ is selected from the group consisting of —CH₂CH₂—, —CH₂CH(CH₃)—, —CH₂CH(CH₂OH)—, —CH₂CH₂CH₂—, and mixtures thereof; each R⁴ is selected from the group consisting of C₁-C₄ alkyl, C₁-C₄ hydroxyalkyl, benzyl ring structures formed by joining the two R⁴ groups, —CH₂CHOH—CHOHCOR⁶CHOHCH₂OH wherein R⁶ is any hexose or hexose polymer having a molecular weight less than about 1000, and hydrogen when y is not 0; R⁵ is the same as R⁴ or is an alkyl chain wherein the total number of carbon atoms of R² plus R⁵ is not more than about 18; each y is from 0 to about 10 and the sum of the y values is from 0 to about 15; and X is any compatible anion.

[0078] Other cationic surfactants useful herein are also described in U.S. Pat. No. 4,228,044, Cambre, issued Oct. 14, 1980.

Solvents

[0079] As an optional but highly preferred ingredient, the composition herein comprises one or more solvents or mixtures thereof. Solvents can provide improved filming and/or streaking benefits. Whilst not wishing to be limited by theory, it is believed that solvents disrupt micelle formation, thus reducing surfactant aggregation. As such, they act as gloss toning agents, reducing gloss loss or promoting gloss gain on the surfaces of the present invention. Solvents are also beneficial because of their surface tension reduction properties help the cleaning profile of the compositions disclosed herein. Finally, solvents, particularly solvents with high vapour pressure, specifically vapour pressures of about 0.05 mm Hg at 25° C. and 1 atmosphere pressure (about 6.66 Pa) or higher, can provide cleaning and filming and/or streaking benefits without leaving residue.

[0080] Solvents for use herein include all those known in the art for use in hard-surface cleaner compositions. Suitable solvents can be selected from the group consisting of: aliphatic alcohols, ethers and diethers having from about 4 to about 14 carbon atoms, preferably from about 6 to about 12 carbon atoms, and more preferably from about 8 to about 10 carbon atoms; glycols or alkoxylated glycols; glycol ethers; alkoxylated aromatic alcohols; aromatic alcohols; terpenes; and mixtures thereof. Aliphatic alcohols and glycol ether solvents are most preferred, particularly those with vapour pressure of about 0.05 mm Hg at 25° C. and 1 atmosphere pressure (about 6.66 Pa).

[0081] Aliphatic alcohols, of the formula R—OH wherein R is a linear or branched, saturated or unsaturated alkyl group of from about 1 to about 20 carbon atoms, preferably from about 2 to about 15 and more preferably from about 5 to about 12, are suitable solvents. Suitable aliphatic alcohols

are methanol, ethanol, propanol, isopropanol or mixtures thereof. Among aliphatic alcohols, ethanol and isopropanol are most preferred because of their high vapour pressure and tendency to leave no residue.

[0082] Suitable glycols to be used herein are according to the formula HO—CR₁R₂—OH wherein R₁ and R₂ are independently H or a C₂-C₁₀ saturated or unsaturated aliphatic hydrocarbon chain and/or cyclic. Suitable glycols to be used herein are dodecaneglycol and/or propanediol.

[0083] In one preferred embodiment, at least one glycol ether solvent is incorporated in the compositions of the present invention. Particularly preferred glycol ethers have a terminal C₃-C₆ hydrocarbon attached to from one to three ethylene glycol or propylene glycol moieties to provide the appropriate degree of hydrophobicity and, preferably, surface activity. Examples of commercially available solvents based on ethylene glycol chemistry include mono-ethylene glycol n-hexyl ether (Hexyl Cellosolve®) available from Dow Chemical. Examples of commercially available solvents based on propylene glycol chemistry include the di-, and tri-propylene glycol derivatives of propyl and butyl alcohol, which are available from Arco under the trade names Arcosolv® and Dowanol®.

[0084] In the context of the present invention, preferred solvents are selected from the group consisting of mono-propylene glycol mono-propyl ether, di-propylene glycol mono-propyl ether, mono-propylene glycol mono-butyl ether, di-propylene glycol mono-propyl ether, di-propylene glycol mono-butyl ether; tri-propylene glycol mono-butyl ether; ethylene glycol mono-butyl ether; di-ethylene glycol mono-butyl ether, ethylene glycol mono-hexyl ether; di-ethylene glycol mono-hexyl ether; and propylene glycol phenyl ether and mixtures thereof. "Butyl" includes normal butyl, isobutyl and tertiary butyl groups.

[0085] Dipropylene glycol n-butyl ether, propylene glycol mono-butyl ether, and propylene glycol phenyl ether are the most preferred cleaning solvent and are available under the tradenames Dowanol DPnB®, Dowanol PnB®, and Dowanol PPh® from Dow Inc.

[0086] The solvent can be purified so as to minimize impurities. Such impurities include aldehydes, dimers, trimers, oligomers and other by-products. These have been found to deleteriously affect product odour, perfume solubility and end result. The inventors have also found that common commercial solvents, which contain low levels of aldehydes, can cause irreversible and irreparable yellowing of certain hard surfaces. By purifying the cleaning solvents so as to minimize or eliminate such impurities, surface damage is attenuated or eliminated.

[0087] Though not preferred, terpenes can be used in the present invention. Suitable terpenes to be used herein mono-cyclic terpenes, dicyclic terpenes and/or acyclic terpenes. Suitable terpenes are: D-limonene; pinene; pine oil; terpinene; terpene derivatives as menthol, terpinol, geraniol, thymol; and the citronella or citronellol types of ingredients.

[0088] Suitable alkoxylated aromatic alcohols to be used herein are according to the formula R-(A)_n-OH wherein R is an alkyl substituted or non-alkyl substituted aryl group of from about 1 to about 20 carbon atoms, preferably from about 2 to about 15 and more preferably from about 2 to about 10, wherein A is an alkoxy group preferably butoxy, propoxy and/or ethoxy, and n is an integer of from about 1

to about 5, preferably about 1 to about 2. Suitable alkoxy-
lated aromatic alcohols are benzoxyethanol and/or benzo-
xypropanol.

[0089] Suitable aromatic alcohols to be used herein are
according to the formula R—OH wherein R is an alkyl
substituted or non-alkyl substituted aryl group of from about
1 to about 20 carbon atoms, preferably from about 1 to about
15 and more preferably from about 1 to about 10. For
example a suitable aromatic alcohol to be used herein is
benzyl alcohol.

Hydrotropes

[0090] Hydrotropes are advantageously used to ensure
solubility of the composition, and in particular to ensure
adequate perfume solubility. Hydrotropes include the
sulfonates of toluene, xylene and cumene, sulfates of naph-
thalene, anthracene, and higher aromatics, and C₃-C₁₀ linear
or branched alkyl benzenes, C₆-C₈ sulfates such as hexyl
sulfate and 2-ethyl-1-hexyl sulfate, short chain pyrrolidones
such as octyl pyrrolidone, and the like. Other preferred
hydrotropes include the oligomers and polymers comprising
polyethylene glycol. In a particularly preferred embodiment,
alkyl ethoxylates comprising at least an average of about 15
moles of ethylene oxide, more preferably at least about 20
moles of ethylene oxide per mole chain length (alcohol) are
advantageously employed. Unlike conventional hydro-
tropes, the preferred alkyl ethoxylate hydrotropes are found
to have little or no impact on the filming and streaking
properties of the compositions of the present invention.
When present, hydrotropes are preferably used at solution
weight percent of from about 0.01% to about 5%, more
preferably about 0.01% to about 0.5%, still more preferably
about 0.03% to about 0.25%.

Packaging Form of the Composition

[0091] The composition can be packaged in any container
that allows proper dispensing of product. Such packages
include, but are not limited to, capped bottled, and spray
bottles. The packages can be made of any material known in
the art, such as plastic or glass.

[0092] The composition can be sold in combination with
other cleaning tools and/or implements. For example, the
compositions can be sold together with sponges or sponge
mops. Alternatively, the compositions are bundled with
commercial paper towels, or with string or strip mops.

[0093] Preferably, the aqueous compositions are packaged
in spray bottles and bundled, or co-branded with a cleaning
implement (spray and mop application). Highly preferably,
the composition is packaged with absorbent disposable
cleaning pads and/or cleaning implements. Kits can also be
sold where such pads are combined with a dispensing bottle
containing composition of the present invention, optionally
packaged together with a cleaning implement. These latter
embodiments can be advantageously marketed and sold as
'starter kits', designed to help consumers leverage all the
power of the composition.

Cleaning Kit for Cleaning and Sanitizing a Hard Surface

[0094] The cleaning kit comprises:

- [0095]** (a) an aqueous acidic hard surface cleaning
liquid composition of the present invention;
- [0096]** (b) a handle;

[0097] (c) a support head pivotally attached to said
handle;

[0098] (d) a disposable cleaning substrate removably
attached to the support head; and

[0099] (e) a liquid delivery system for providing the
cleaning liquid composition (a) to a surface to be
cleaned and sanitized.

[0100] A preferred aqueous acidic hard surface cleaning
liquid composition for use in the cleaning kit comprises, by
weight of the composition:

[0101] (a) from 0.08 wt % to 0.3 wt % C₁₂-C₁₄ amine
oxide surfactant;

[0102] (b) from 0.5 wt % to 1.5 wt % citric acid;

[0103] (c) from 0.1 wt % to 0.3 wt % formic acid, and

[0104] (d) from 0.1 wt % to 0.7 wt % glycol ether
solvent,

[0105] wherein the pH of the liquid cleaning composi-
tion is from 1.9 to 2.5.

Process for Cleaning a Surface

[0106] The process of cleaning a surface, preferably a hard
surface, typically comprises the step of contacting, prefer-
ably wiping, said surface using the composition of the
present invention. Preferably, the process comprises the
steps of contacting parts of said surface, more preferably
soiled parts of said surface, with said composition.

[0107] By "hard-surfaces", it is meant herein any kind of
surfaces typically found in houses like kitchens, bathrooms,
e.g., floors, walls, tiles, windows, sinks, showers, shower
plastified curtains, wash basins, WCs, dishes, fixtures and
fittings and the like made of different materials like ceramic,
vinyl, no-wax vinyl, linoleum, melamine, glass, any plastics,
plastified wood, metal or any painted or varnished or sealed
surface and the like. Hard-surfaces also include household
appliances including, but not limited to, refrigerators, freez-
ers, washing machines, automatic dryers, ovens, microwave
ovens, dishwashers and so on.

Reserve Acidity

[0108] Reserve acidity is defined as the amount of sodium
hydroxide in grams needed to increase by 1 unit the pH of
100 g of product at 25° C.

[0109] Reserve acidity per total acid level is defined as the
reserve acidity of the composition divided by the total acid
level in weight percent of the composition.

Examples

Methods:

Reserve Acidity

[0110] The reserve acidity of the compositions was mea-
sured by adding sodium hydroxide to 100 ml of each
composition under constant stirring until all compositions
reached a pH of 3.5 at 25° C., at this point, 50% NaOH was
added to each composition at 0.1 g increments until the pH
at 25° C. increased to 4.5.

[0111] The reserve acidity of each composition was cal-
culated as g of NaOH (100%)/100 g product needed to
increase the pH of each composition from 3.5 to 4.5 and it
is shown in table 1.

[0112] The reserve acidity per total acid level was calculated by dividing the reserve acidity of each composition by the total acid level present in the composition.

Antibacterial Efficacy

Bacterial Inoculum Preparation for Test

[0113] The bacteria inoculum was prepared by transferring several colonies from a Tryptone Soy Agar (TSA) plate to a saline solution (0.85% NaCl), the bacteria concentration in this saline solution was determined by measuring the % Transmittance at 425 nm and adjusted by either adding more bacteria or more saline solution until the % Transmittance at 425 nm was between 23-25% for *Staphylococcus aureus* ATCC 6358 (S.a.). This % transmittance corresponds to a bacteria concentration of 10^8 CFU/ml.

[0114] This 10^8 CFU/ml inoculum was centrifuged at 5000 rpm for 20 mins at 24° C. (Eppendorf Centrifuge 5810R with Eppendorf Swing-bucket rotor A-4-81), and the bacteria pellet was resuspended in $\frac{1}{10}$ of the original inoculum volume in saline containing 5% of fetal bovine serum. The bacteria concentration in this inoculum is 10^9 CFU/ml.

Determination of Antibacterial Efficacy

[0115] Sterilized glass coverslips were placed into each well of a 6-well CytoOne® Plate and 20 μ L of the 10^9 CFU/ml bacteria inoculum prepared as described in above section was pipetted in a spot in the center of each coverslip. The plate was placed in an incubator at 36° C. for 25-35 mins until the inoculated bacteria was dry.

[0116] 40 μ L of composition was added to the inoculated coverslips ensuring that the area containing the bacteria was fully covered with the composition. The composition was kept in contact with the bacteria for 5 mins or any other contact time indicated in the examples. After this contact time, 5 ml of regular Lethen Broth was added to each well and the plate was placed in an orbital shaker set to 150 RPM for 5 minutes.

[0117] To determine the antibacterial efficacy of each composition, 1 ml of the Lethen Broth from each well was added to a commercial Neogen NF-TVC Seleris vial and bacteria growth was monitored at 34° C. for 24 hours in a Seleris Next Generation equipment. The Seleris Next Generation monitors microbial activity by CO₂ production. The time to detect bacteria growth in Seleris is proportional to the number of live bacteria remaining on the coverslip after treating with each composition, with longer growth detection times indicating compositions with better antibacterial efficacy, and no growth indicating complete kill. Positive control-bacteria with no treatment-, and negative control-clean coverslip nil bacteria-, were included in all the tests.

Surface Shine Method

[0118] Filming/streaking is an important property of hard surface cleaning products as it influences the consumer's perception of the product's cleaning performance.

[0119] This test method enables the evaluation of the neat filming/streaking performance, also referred to as "shine profile" or simply "shine", of different compositions on hard, black, glossy ceramic tiles of about 20 cm×25 cm under realistic conditions, using dry, white kitchen roll (Plenty UK brand or Bounty NA brand).

[0120] Prior to the test tiles are cleaned with a bleach containing hard surface cleaner by scrubbing vigorously with a clean sponge under hot water, rinsed and dried immediately with a white paper towel. After this wash step, tiles are treated with isopropylalcohol (IPA) or with ethanol, wiped with white paper towel and allowed to dry at room temperature. This washing and alcohol treatment steps ensure tiles are free of smears and particulates prior to each test.

[0121] Test compositions (225 μ L) were applied diagonally from the bottom left corner to the top right corner of each respective tile, and wiped with a dry white kitchen paper towel of 8 cm×10 cm in a '3-M' motion from left to right covering entire surface in 6 passes, this wiping pattern was then repeated, without lifting the paper towel from the tile, from top to bottom, and from right to left, finishing at the bottom right.

[0122] Tiles were left to dry flat on a bench for 2 hours and graded by at least 3 panelists according to the grading scale shown below:

- [0123] 0—No streaks
- [0124] 1—Very Light Streaks
- [0125] 2—Light Streaks
- [0126] 3—Light to Medium Streaks
- [0127] 4—Medium Streaks
- [0128] 5—Medium to Heavy Streaks
- [0129] 6—Heavy Streaks

Examples

[0130] Table 1 shows the reserve acidity of comparative composition C-1 comprising 1% citric acid as extra acid, and composition A-1 of the present invention comprising 0.25% formic acid as extra acid, vs a reference composition comprising 1% citric acid.

TABLE 1

	Reference	C-1	A-1
C12-C14 Amine Oxide	0.1%	0.1%	0.1%
Citric acid	1%	1%	1%
Extra acid- Citric acid	—	1%	—
Extra acid- Formic acid	—	—	0.25%
Glycol ether Solvent (1)	0.4%	0.4%	0.4%
Glycol ether Solvent (2)	0.2%	0.2%	0.2%
Minors	0.031%	0.031%	0.031%
Water	To 100%	To 100%	To 100%
Total Acid	1%	2%	1.25%
Reserve Acidity (g NaOH/100 g)	0.25	0.5	0.45
Reserve acidity per total acid ((g NaOH/100 g)/total weight % acid)	0.25	0.25	0.36
Increase in reserve acidity per amount (in weigh %) of extra acid added	—	0.25	0.8

(1) Propylene glycol mono butyl ether- Dowanol® PnB- DOW

(2) Propylene glycol phenyl ether - Dowanol® Pph- DOW

[0131] It can be seen that the addition of 0.25% formic acid as extra acid to the reference composition containing 1% citric acid results in an increase in reserve acidity per amount of acid added 3.2 times higher than the one obtained by adding 1% citric acid as extra acid to the same reference composition. The increase in reserve acidity per amount of acid is calculated as:

$$\frac{(\text{reserve acidity sample} - \text{reserve acidity reference})}{\text{amount in weigh \% of extra acid added.}}$$

[0132] Compositions with high reserve acidity at low total acid concentration are highly preferred as they are milder to skin and eyes; and have a better overall shine performance.

[0133] Table 2 shows the antibacterial efficacy, and shine scores of comparative compositions C-2, and C-3 and of inventive compositions A-1, A-2, and A-3.

[0137] Inventive composition A-3 show that different combinations of amine oxide surfactant with citric acid and formic acid show better antibacterial efficacy than comparative compositions C-2 and C-3.

[0138] The dimensions and values disclosed herein are not to be understood as being strictly limited to the exact

	C-2	C-3	A-1	A-2	A-3
C12-C14	—	0.1%	0.1%	0.1%	0.22%
Amine Oxide					
Linear	0.05%	—	—	—	—
alkylbenzene					
sulfonate					
C8-C10 APG	0.05%	—	—	—	—
Citric acid	0.35%	—	1%	0.35%	0.25%
Lactic Acid	—	1%	—	—	—
Formic acid	0.1%	0.25%	0.25%	0.1%	0.125%
Glycol ether	—	0.4%	0.4%	—	—
Solvent (1)					
Glycol ether	—	0.2%	0.2%	—	—
Solvent (2)					
Minors (3)	—	0.031%	0.031%	—	0.04%
Water	To 100%	To 100%	To 100%	To 100%	To 100%
pH	2.2	2.2	2.2	2.2	2.2
Antimicrobial	10 h	9.8 h	No Growth	14.7 h	16.2 h
Efficacy			Total Kill		
Time (h) to					
detect growth					
in Soleris					
Shine Score	2	4	1	1	1

(1) Propylene glycol mono butyl ether- Dowanol® PnB- DOW

(2) Propylene glycol phenyl ether - Dowanol® Pph- DOW

(3) Antifoam and perfume (C-3 and A-1), Perfume (A-3)

[0134] Table 2 shows the antibacterial efficacy of comparative compositions C-2 and C-3 outside the scope of the present invention, and of inventive compositions A-1, A-2, A-3. Antibacterial efficacy was measured against *S. aureus* on glass surfaces under soiled conditions at 5 minutes contact time. The data shown are time in hours to detect bacterial growth in Neogen NF-TVC Soleris vials using a Neogen Soleris Next Generation equipment. Bacterial growth was monitored for 24 hours. Longer time to detect growth indicates compositions with better antibacterial efficacy. If growth is not detected during the 24 h period, we consider that the treatment with the composition results in complete kill of the bacterial inoculum.

[0135] From the data of comparative composition C-2 vs inventive composition A-2, both having equal acid system and different surfactant system, it can be seen that the inventive composition A-2 comprising 0.1% of amine oxide as surfactant shows better antibacterial efficacy and better shine than comparative composition C-2 comprising 0.1% surfactant blend containing 0.05% of linear alkylbenzene sulfonate and 0.05% of an alkyl polyglucoside surfactant.

[0136] Comparing the antibacterial efficacy of comparative composition C-3 and inventive composition A-1, both comprising 0.1% of amine oxide as surfactant and different acid systems, it can be clearly seen that inventive composition A-1 comprising an acid system containing 1% citric acid and 0.25% formic acid shows much better antibacterial efficacy and shine performance than comparative composition C-3 containing 1% lactic acid and 0.25% formic acid.

numerical values recited. Instead, unless otherwise specified, each such dimension is intended to mean both the recited value and a functionally equivalent range surrounding that value. For example, a dimension disclosed as “40 mm” is intended to mean “about 40 mm”.

[0139] Every document cited herein, including any cross referenced or related patent or application, is hereby incorporated herein by reference in its entirety unless expressly excluded or otherwise limited. The citation of any document is not an admission that it is prior art with respect to any invention disclosed or claimed herein or that it alone, or in any combination with any other reference or references, teaches, suggests or discloses any such invention. Further, to the extent that any meaning or definition of a term in this document conflicts with any meaning or definition of the same term in a document incorporated by reference, the meaning or definition assigned to that term in this document shall govern.

[0140] While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

What is claimed is:

1. An aqueous acidic hard surface cleaning liquid composition comprising by weight of the composition:

(a) from about 0.05 wt % to about 2.5 wt % amine oxide surfactant;

(b) from about 0.15 wt % to about 4.00 wt % citric acid; and

(c) from about 0.05 wt % to about 0.5 wt % formic acid; wherein the composition has a pH in the range of from about 1.9 to about 2.5.

2. The composition of claim 1, wherein the composition comprises, by weight of the composition:

(a) from about 0.175 wt % to about 3.0 wt % citric acid; and

(b) from about 0.050 wt % to about 0.5 wt % formic acid, wherein the weight ratio of citric acid to formic acid is in the range of from about 60:1 to about 2.0:1.

3. The composition according to claim 1, wherein the composition comprises, by weight of the composition:

(a) from about 0.5 wt % to about 1.5 wt % citric acid; and

(b) from about 0.050 wt % to about 0.35 wt % formic acid, wherein the weight ratio of citric acid to formic acid is in the range of from about 30:1 to about 3.0:1.

4. The composition according to claim 1, wherein the composition further comprises, by weight of the composition, from about 0.05 wt % to about 0.8 wt % glycolic acid.

5. The composition according to claim 1, wherein the composition further comprises, by weight of the composition, from about 0.1 wt % to about 0.4 wt % glycolic acid.

6. The composition according to claim 1, wherein the composition comprises, by weight of the composition, from about 0.08 wt % to about 0.45 wt % amine oxide surfactant.

7. The composition according to claim 1, wherein the amine oxide surfactant is a C₁₂-C₁₄ amine oxide surfactant.

8. The composition according to claim 1, wherein the composition further comprises, by weight of the composition, from about 0.1 wt % to about 1.0 wt % ether alcohol solvent.

9. The composition according to claim 8, wherein the ether alcohol solvent is selected from dipropylene glycol n-butyl ether, propylene glycol mono-butyl ether, propylene glycol phenyl ether and any combination thereof.

10. The composition according to claim 1, wherein the composition has a reserve acidity of at least about 0.15 g NaOH per 100 g product measured at 25° C.

11. The composition according to claim 1, wherein the composition further comprises one or more of the following ingredients selected from perfume, pH stabilizer, dye, anti-

foam agent, polymer, additional surfactant, preservative, chelant, hydrotrope, and any combination thereof.

12. The composition according to claim 1, wherein the composition comprises, by weight of the composition, from about 90 wt % to about 99.65 wt % water.

13. The composition according to claim 1, wherein the composition comprises, by weight of the composition:

(a) from about 0.08 wt % to about 0.3 wt % C₁₂-C₁₄ amine oxide surfactant;

(b) from about 0.5 wt % to about 1.5 wt % citric acid;

(c) from about 0.1 wt % to about 0.3 wt % formic acid, and

(d) from about 0.1 wt % to about 0.7 wt % glycol ether solvent,

wherein the pH of the liquid cleaning composition is from about 1.9 to about 2.5.

14. A cleaning kit for cleaning and sanitizing a hard surface, wherein the kit comprises:

(a) an aqueous acidic hard surface cleaning liquid composition according to claim 1;

(b) a handle;

(c) a support head pivotally attached to said handle;

(d) a disposable cleaning substrate removably attached to the support head; and

(e) a liquid delivery system for providing the cleaning liquid composition (a) to a surface to be cleaned and sanitized.

15. The cleaning kit according to claim 14, wherein the aqueous acidic hard surface cleaning liquid composition comprises, by weight of the composition:

(a) from about 0.08 wt % to about 0.3 wt % C₁₂-C₁₄ amine oxide surfactant;

(b) from about 0.5 wt % to about 1.5 wt % citric acid;

(c) from about 0.1 wt % to about 0.3 wt % formic acid, and

(d) from about 0.1 wt % to about 0.7 wt % glycol ether solvent,

wherein the pH of the liquid cleaning composition is from about 1.9 to about 2.5.

* * * * *