

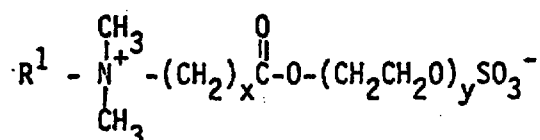
TECHNICAL FIELD

5 The present application relates to cationic compounds having clay-soil removal/anti-redeposition properties when used in detergent compositions.

A particularly important property of a detergent composition is its ability to remove particulate type soils from a variety of fabrics during laundering. Perhaps the most important particulate
10 soils are the clay-type soils. Clay soil particles generally comprise negatively charged layers of aluminosilicates and positively charged cations (e.g. calcium) which are positioned between and hold together the negatively charged layers.

A variety of models can be proposed for compounds which would
15 have clay soil removal properties. One model requires that the compound have two distinct characteristics. The first is the ability of the compound to adsorb onto the negatively charged layers of the clay particle. The second is the ability of the compound, once adsorbed, to push apart (swell) the negatively
20 charged layers so that the clay particle loses its cohesive force and can be removed in the wash water.

One class of clay-soil removal compounds which appears to work according to this model are the polyethoxy zwitterionic surfactants disclosed in U.S. Patent 4,301,044 to Wentler et al.,
25 issued November 17, 1981. Representative of such compounds are those having the formula:



30 *wherein R^1 is a C_{14} - C_{20} alkyl group; x is 1 or an integer of from 3 to 5; and y is from 6 to 12. See also U.S. Patent 3,929,678 to Laughlin et al., issued December 30, 1975 (detergent composition containing polyethoxy zwitterionic surfactant plus other detergent surfactants); U.S. Patent 3,925,262 to Laughlin et al., issued
35 December 9, 1975 (detergent composition containing polyethoxy zwitterionic surfactants with detergent builders); U.S. Patent

4,157,277 to Gosselink et al., issued June 26, 1979 (C₄ polyoxy-alkylene zwitterionic surfactants useful in detergent compositions); U.S. Patent 4,165,334 to Gosselink et al., issued August 21, 1979 (sulfonium-type polyethoxy zwitterionic surfactants).

5 These polyethoxy zwitterionic surfactants are generally compatible with other detergent surfactants such as the nonionic, zwitterionic and ampholytic types. However, as indicated in the Wentler et al. patent, most anionic surfactants interfere with the particulate soil removal performance of these compounds; anionic
10 soils such as fatty acids likewise interfere. Because anionic detergent surfactants form the most important class of such materials for use in detergent compositions, the lack of compatibility between these polyethoxy zwitterionic surfactants and anionic surfactants poses a significant handicap where particulate
15 (clay) soil removal is desired.

 In addition to clay soil removal, one of the other properties mentioned in the Laughlin et al. patents with regard to these polyethoxy zwitterionic surfactants is the ability to keep the removed soil in suspension during the laundering cycle. Soil
20 which is removed from the fabric and suspended in the wash water can redeposit onto the surface of the fabric. This redeposited soil causes a dulling or "graying" effect which is especially noticeable on white fabrics. Because soil is normally hydrophobic, this graying effect is a particularly important problem for
25 those fabrics made in total or in part from hydrophobic fibers, e.g. polyester.

 To minimize this problem, anti-redeposition or whiteness maintenance agents can be included in the detergent composition. Besides the previously mentioned polyethoxy zwitterionic surfac-
30 tants, there are a variety of other compounds which can be used as anti-redeposition agents. One class of agents are the water-soluble copolymers of acrylic or methacrylic acid with acrylic or methacrylic acid-ethylene oxide condensates disclosed in U.S. Patent 3,719,647 to Hardy et al., issued March 6, 1973. Another
35 class of anti-redeposition agents are the cellulose and carboxymethylcellulose derivatives disclosed in U.S. Patent

3,597,416 to Diehl, issued August 3, 1971 (ionic combination of dodecyltrimethyl phosphonium chloride and sodium carboxymethyl cellulose), and U.S. Patent 3,523,088 to Dean et al., issued August 4, 1970 (anti-redeposition agent consisting of alkali metal carboxymethylcellulose and hydroxypropylcellulose). A mixture of compounds has also been used to provide not only anti-redeposition, but also clay soil removal properties. See U.S. Patent 4,228,044 to Cambre, issued October 14, 1980, which discloses detergent compositions having anti-redeposition and clay soil removal properties which can comprise a nonionic alkyl polyethoxy surfactant, a polyethoxy alkyl quaternary cationic surfactant and a fatty amide surfactant.

These anti-redeposition agents do have a number of significant handicaps. While effective to keep soil suspended, these compounds may lack additional clay soil removal properties. Moreover, as disclosed in the Diehl and Dean et al. patents, mixtures of compounds can be required to achieve the anti-redeposition benefit. To the extent that there are combined anti-redeposition/clay soil removal benefits as disclosed in the Cambre patent, mixtures of compounds are also required.

It is therefore an object of the present invention to provide compounds useful in detergent compositions which provide particulate soil, in particular clay soil, removal benefits.

It is a further object of the present invention to provide compounds useful in detergent compositions which provide clay soil removal benefits and are anionic detergent surfactant compatible.

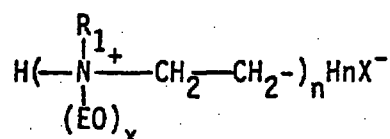
It is yet another object of the present invention to provide compounds useful in detergent compositions having anti-redeposition properties.

It is yet a further object of the present invention to provide compounds useful in detergent compositions which combine both clay soil removal and anti-redeposition properties.

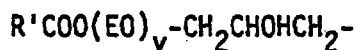
These and further objects of the present invention are hereinafter disclosed.

BACKGROUND ART

U. S. Patent 3,838,057 to Barnes et al., issued September 24, 1974, discloses toilet bars containing ethoxylated quaternary ammonium compounds, including ethoxylated, quaternized polyethyleneimines (PEIs) taught to be useful in the detergent, textile, and polymer industries, as anti-static and softening agents. These ethoxylated quaternized PEIs have the formula:

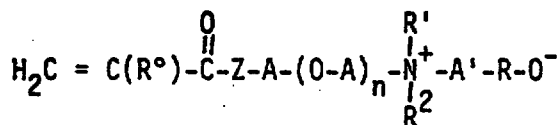


wherein R_1 is a compatible quaternary nitrogen substituent; n is at least 2; x is from 3 to 40; and X^- is a compatible anion. Preferred compounds are those where R_1 is a $\text{C}_8 - \text{C}_{22}$ alkyl group or the group:



where R' is a $\text{C}_8 - \text{C}_{22}$ alkyl group and y is from 3 to 40. See also U. S. Patent 4,179,382 to Rudkin et al., issued December 18, 1979; U. S. Patent 4,152,272 to Young, issued May 1, 1979; and European Application 2,085 to Rudkin et al., published May 30, 1979, which disclose ethoxylated quaternized polyamines having C_{10} to C_{24} alkyl or alkenyl groups attached to one of the nitrogen atoms useful as fabric softeners.

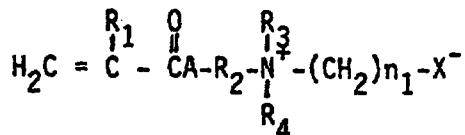
U.S. Patent 3,671,305 to Brown et al. issued June 20, 1972, discloses zwitterionic monomers which form polymers used to treat films, sheets, and filamentary materials so as to give them a durable, hydrophilic, anti-static, anti-soiling, soil releasing finish. These monomers have the formula:



wherein n is 0 to 10; R^0 is hydrogen or methyl; Z is oxygen or ---NH--- ; A can be a $\text{C}_2\text{---C}_3$ alkylene group (e.g. ethylene) when n is 1-10; R' and R^2 can be $\text{C}_1\text{---C}_4$ alkyl; A' is $\text{C}_1\text{---C}_4$ alkylene; and R can be SO_2 .

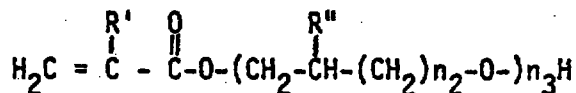
U.S. Patent 3,671,502 to Samour et al. issued June 20, 1972, discloses co-polymers useful as binders in the production of non-wovens. These co-polymers consist essentially of from about 5 to about 90% of a monomer having the formula:

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wherein R_1 is hydrogen or methyl; A is oxygen or -NH-; R_2 is ethylene, propylene, 2-hydroxypropylene or 2-acetoxypylene; R_3 and R_4 are alkyl; n_1 is 1 to 4; and X^- is SO_3^- or CO_2^- ; and from about 10 to about 95% by weight of a hydroxyacrylate such as a polyglycerol acrylate/methacrylate having the formula:

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wherein R' is hydrogen or methyl; R'' is hydrogen, methyl or hydroxy; n_2 is 0 when R'' is hydrogen or methyl (e.g. an ethylene group); and n_3 is 2 to 4.

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U. S. Patent 3,301,783 to Dickson, et al., issued January 31, 1967, discloses oxyalkylated, acylated, alkylated, carbonylated and olefinated derivatives of polyalkyleneimines, in particular polyethyleneimines (PEIs). For the oxyalkylated derivatives, the alkylene oxide (e.g. ethylene oxide) is reacted with the polyalkyleneimine in a mole ratio of from 1:1 to 1000:1, and preferably in a ratio of from 1:1 to 200:1. Among the ethoxylated PEIs disclosed are Examples 1-0₇ and 1-0₈ formed by condensing 105 and 200 moles, respectively, of ethylene oxide with a 900 M.W. PEI. The degree of ethoxylation calculates out to about 4.5 and about 8 ethoxy groups per reactive site, respectively. See also Examples 27-0₅ and 27-0₆ which disclose ethoxylated polypropyleneimines (M.W. 500) which have about 4 and about 8 ethoxy units per reactive site, respectively. Amongst the numerous disclosed uses of these polyalkyleneimine derivatives is a teaching that they are useful as detergents, softening agents, and anti-static agents. Preferred uses disclosed by this patent are as chelating agents, lubricating oil additives, emulsifying agents, and cutting oils.

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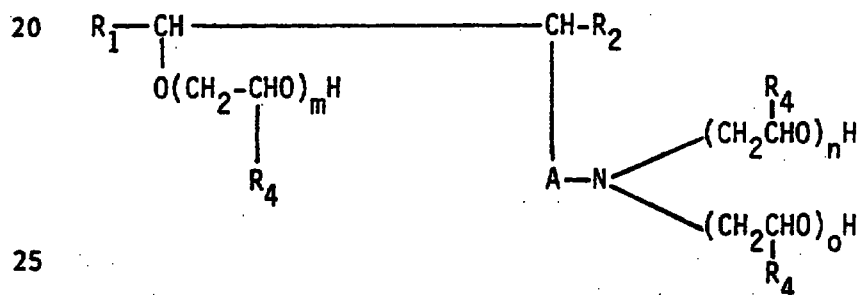
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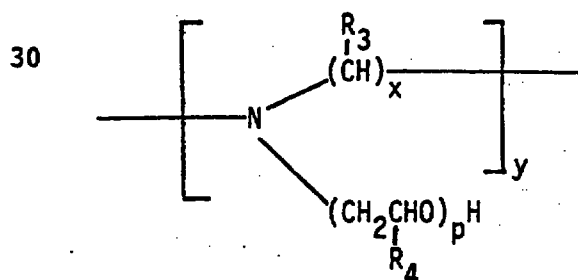
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U.S. Patent 2,792,371 to Dickson, issued May 14, 1957, teaches a process for breaking petroleum emulsions with oxyalkylated tetraethylene pentaamines (TEPA). Ethoxylated TEPAs specifically disclosed include those having about 5 (Example 3aa),
 5 about 7 (Example 4aa), about 8.5 (Example 5a) and about 15.5 (Example Bc) ethoxy units per reactive site. Similarly, U.S. patent 2,792,370 to Dickson issued May 14, 1957, teaches a process for breaking petroleum emulsions with oxyalkylated triethylene tetramines (TETAs) including those having about 5.5 (Example 3aa),
 10 about 7.5 (Example 4aa), about 9 (Example 5a) and about 16.5 (Example Bc) ethoxy units per reactive site. See also U. S. patent 2,792,372 to Dickson, issued May 14, 1957, (oxyalkylated higher PEAs used to break petroleum emulsions); U. S. patent 2,792,369 to Dickson, issued May 14, 1957 (oxyalkylated diethylene triamines used to break petroleum emulsions).
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U. S. Patent 4,171,278 to Andree et al., issued October 16, 1979, discloses cold water detergent compositions containing a detergent surfactant (e.g. anionic) and a hydroxyalkyl amine in a weight ratio of 100:1 to 1:1. The amine can have the formula:



wherein R_1 is C_1 - C_{16} alkyl; R_2 is H or C_1 - C_{16} alkyl; $R_1 + R_2$ have 6-20 carbon atoms; R_4 is H or methyl; m, n, and o, are each 0 to 3 and A is bridging group such as



wherein R_3 is H or methyl; x is 2 to 6; y is 1 to 3; and p is 0 to

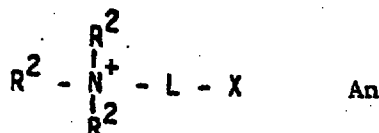
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3; the sum of m to p being 1 to 5.5, and preferably 1 to 2. See also German Patent Document 2,165,900 to Henkel, published July 5, 1973, which discloses a washing agent for graying prevention formed by the reaction product of a PEI with an alkylglycidylether and ethylene oxide (2-hydroxyethyl moiety at each reactive site).

There are several patents which disclose detergent compositions, shampoo compositions and the like containing slightly ethoxylated PEIs (ethylene oxide:PEI weight ratio of 4:1 or less) to enhance the deposition and retention of particulate substances such as antimicrobials. See, for example, U.S. Patent 3,489,686 to Parran, issued January 13, 1970; U.S. Patent 3,580,853 to Parran, issued May 25, 1971; British Patent Specification 1,111,708 to Procter & Gamble published May 1, 1968, U.S. Patent 3,549,546 to Moore, issued December 22, 1970; and U.S. Patent 3,549,542 to Holderby, issued December 22, 1970.

DISCLOSURE OF THE INVENTION

The present invention relates to detergent compositions which comprise from 0.05 to 95% by weight of water-soluble cationic compounds having clay soil removal/ anti-redeposition properties. These compounds are selected from ethoxylated cationic monoamines having the formula:



wherein each R^2 is C_1 - C_4 alkyl or hydroxyalkyl, the moiety $-\text{L}-\text{X}$, or two R^2 together form the moiety $-(\text{CH}_2)_r-\text{A}^2-(\text{CH}_2)_s-$, wherein A^2 is $-\text{O}-$ or $-\text{CH}_2-$, r is 1 or 2, s is 1 or 2 and $r + s$ is 3 or 4; X is a nonionic group selected from H , C_1 - C_4 alkyl or hydroxyalkyl ester or C_1 - C_4 alkyl or hydroxyalkyl ether groups; L is a hydrophilic chain consisting of the polyoxyalkylene

moiety $-(R^6O)_m(CH_2CH_2O)_n-$, wherein R^6 is C_3-C_4 alkylene or hydroxyalkylene, n is a number of at least 12 such that the moiety $-(CH_2CH_2O)_n-$ comprises at least 50% by weight of said polyoxyalkylene moiety; m is from 0 to 5; and An represents an equivalent number of counteranions.

In addition to the cationic compounds, the detergent compositions further comprise from 1 to 75% by weight of a nonionic, anionic, ampholytic, zwitterionic, or cationic detergent surfactant or mixture thereof. In addition to these detergent surfactants, the detergent composition can optionally comprise from 0 to about 80% by weight of a detergent builder.

The cationic compounds provide clay soil removal benefits while being anionic detergent surfactant compatible. It is believed that the positively charged cationic groups cause adsorption of the compound onto the negatively charged layers of the clay particle. It is also believed that the hydrophilic ethoxy units attached to the compound swell the clay particle so that it loses its cohesive character and is swept away in the wash water.

The anti-redeposition benefits provided by these cationic compounds are also believed to be due to the positively charged cationic groups which cause it to be adsorbed onto soil suspended in the wash water. As more and more of these compounds adsorb onto the suspended soil, it becomes encased within a hydrophilic layer provided by the attached ethoxy units. As such, the hydrophilically encased soil is prevented from redepositing on fabrics, in particular hydrophobic fabrics such as polyester, during the laundering cycle.

Cationic Amines

The water-soluble cationic compounds are ethoxylated cationic monoamines as previously defined.

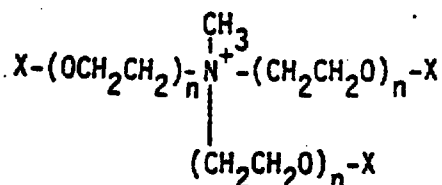
In the preceding formula for the cationic amines, each R^2 is preferably methyl or the moiety $-L-X$.

The positive charge of the N^+ groups is offset by the appropriate number of counter anions. Suitable counter anions include Cl^- , Br^- , SO_3^{-2} , SO_4^{-2} , PO_4^{-2} , $MeOSO_3^-$ and the like. Particularly preferred counter anions are Cl^- and Br^- .

5 X can be a nonionic group selected from hydrogen (H), C_1 - C_4 alkyl or hydroxyalkyl ester or ether groups, or mixtures thereof. Preferred esters or ethers are the acetate ester and methyl ether, respectively. The particularly preferred nonionic groups are H and the methyl ether.

10 In the preceding formulas, hydrophilic chain L consists entirely of the polyoxyalkylene moiety $-[(R^6O)_m(CH_2CH_2O)_n]-$. The moieties $-(R^6O)_m-$ and $-(CH_2CH_2O)_n-$ of the polyoxyalkylene moiety can be mixed together or preferably form blocks of $-(R^6O)_m-$ and $-(CH_2CH_2O)_n-$ moieties. R^6 is preferably C_3H_6 (propylene); m is from 0 to 5 and is preferably 0, i.e. the polyoxyalkylene moiety consists entirely of the moiety $-(CH_2CH_2O)_n-$. The moiety $-(CH_2CH_2O)_n-$ preferably comprises at least 85% by weight of the polyoxyalkylene moiety and most preferably 100% by weight (m is 0).

20 Preferred ethoxylated cationic monoamines have the formula:



25 wherein X and n are defined as before. For cationic monoamines, n is at least 12, with a typical range of from 15 to 35.

The cationic compounds are included in the composition of the invention at a level of from 0.05 to 95% by weight, preferably from 0.1 to 10% by weight and more preferably from 1% to 3% by weight.

Methods for Making Cationic Amines

The ethoxylated cationic amines can be prepared by standard methods for ethoxylating and quaternizing amines. There is preferably an initial step of condensing sufficient ethylene oxide to provide 2-hydroxyethyl groups at each reactive site (hydroxyethylation). This initial step can be omitted by starting with a 2-hydroxyethyl amine. The appropriate amount of ethylene oxide is then condensed with these 2-hydroxyethylamines using an alkali metal (e.g., sodium, potassium), or a hydride or hydroxide thereof, as the catalyst to provide the respective ethoxylated amines. The total degree of ethoxylation per reactive site (n) can be determined according to the following formula:

$$\text{Degree of Ethoxylation} = E/(A \times R)$$

wherein E is the total number of moles of ethylene oxide condensed (including hydroxyethylation), A is the number of moles of the starting amine, and R is the number of reactive sites (typically 3 for the mono-amines) for the starting amine. The ethoxylated amine can then be quaternized with an alkyl halide such as methyl bromide to form the ethoxylated cationic amine.

Example 1

Step 1: Ethoxylation

Dried triethanolamine (TEA) (16.01 g., 0.107 moles) was catalyzed with 0.5 g. (0.0125 moles) 60% NaH in mineral oil. Ethylene oxide (EO) was then added under atmospheric pressure with stirring at 150°-170°C. After 23 hrs. 36.86 g. (8.38 moles) of EO had been added to give a calculated total degree of ethoxylation of 26.1. The ethoxylated TEA (PEI 17) was a light brown waxy solid.

Step 2: Quaternization

A portion of the ethoxylated TEA (31.68 g., 0.0088 moles) from step 1 was dissolved in H₂O to give about a 50% solution. The solution was heated 60°-70°C while being stirred magnetically. Methyl bromide gas was swept through the reactor for 8 hrs., with sodium bicarbonate being added as needed to maintain the pH at 7 or greater. After quaternization, the solution was dialized for 3 hrs. to remove the salts. Then the solution was diluted to give 10% aqueous slightly cloudy gold colored solution containing the ethoxylated, quaternized TEA.

Detergent Surfactants

The amount of detergent surfactant included in the detergent compositions of the present invention can vary from 1 to 75% by weight of the composition depending upon the detergent surfactant(s) used, the type of composition to be formulated (e.g. granular, liquid) and the effects desired. Preferably, the detergent surfactant(s) comprises from 10 to 50% by weight of the composition. The detergent surfactant can be nonionic, anionic, ampholytic, zwitterionic, cationic, or a mixture thereof:

A. Nonionic Surfactants

Suitable nonionic surfactants for use in detergent compositions of the present invention are generally disclosed in U.S. Patent 3,929,678 to Laughlin et al., issued December 30, 1975 at column 13, line 14 through column 16, line 6.

Classes of nonionic surfactants included are:

1. The polyethyleneoxide condensates of alkyl phenols.

These compounds include the condensation products of alkyl phenols having an alkyl group containing from about 6 to 12 carbon atoms in either a straight chain or branched chain configuration with ethylene oxide, the ethylene oxide being present in an amount equal to 5 to 25 moles of ethylene oxide per mole of alkyl phenol. The alkyl substituent in such compounds can be derived, for example, from polymerized propylene, diisobutylene, and the like.

Examples of compounds of this type include nonyl phenol condensed with about 9.5 moles of ethylene oxide per mole of nonyl phenol; dodecylphenol condensed with about 12 moles of ethylene oxide per mole of phenol; dinonyl phenol condensed with about 15 moles of ethylene oxide per mole of phenol; and diisooctyl phenol condensed with about 15 moles of ethylene oxide per mole of phenol. Commercially available nonionic surfactants of this type include Igepal CO-630, marketed by the GAF Corporation, and Tricon (RTM) X-45, X-114, X-100, and X-102, all marketed by the Rohm & Haas Company.

2. The condensation products of aliphatic alcohols with from about 1 to about 25 moles of ethylene oxide. The alkyl chain of the aliphatic alcohol can either be straight or branched, primary or secondary, and generally contains from about 8 to about 22 carbon atoms. Examples of such ethoxylated alcohols include the condensation product of myristyl alcohol condensed with about 10 moles of ethylene oxide per mole of alcohol; and the condensation product of about 9 moles of ethylene oxide with coconut alcohol (a mixture of fatty alcohols with alkyl chains varying in length from 10 to 14 carbon atoms). Examples of commercially available nonionic surfactants of this type include Temdol (RTM) 15-S-9, marketed by Union Carbide Corporation, Neodol 45-9, Neodol 23-6.5, Neodol 45-7, and Neodol 45-4, marketed by Shell Chemical Company, and Kyro (RTM) EOB, marketed by The Procter & Gamble Company.

3. The condensation products of ethylene oxide with a hydrophobic base formed by the condensation of propylene oxide with propylene glycol. The hydrophobic portion of these compounds has a molecular weight of from about 1500 to 1800 and exhibits 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 (RTM) surfactants, marketed by Wyandotte Chemical Corporation.

4: The condensation products of ethylene oxide with the product resulting from the reaction of propylene oxide and ethylenediamine. The hydrophobic moiety of these products consists of the reaction-product of ethylenediamine and excess propylene oxide, the moiety having a molecular weight of from about 2500 to about 3000. This hydrophobic moiety is condensed with ethylene oxide to the extent that the condensation product contains from about 40% to about 80% by weight of polyoxyethylene and has a molecular weight of from about 5,000 to about 11,000. Examples of this type of nonionic surfactant include certain of the commercially available Tetronic (RTM) compounds, marketed by Wyandotte Chemical Corporation.

5. Semi-polar nonionic detergent surfactants which include water-soluble amine oxides containing one alkyl moiety of from about 10 to 18 carbon atoms and 2 moieties selected from the group consisting of alkyl groups and hydroxyalkyl groups containing from 1 to about 3 carbon atoms; water-soluble phosphine oxides containing one alkyl moiety of from about 10 to 18 carbon atoms and 2 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.

Preferred semi-polar nonionic detergent surfactants are the amine oxide detergent surfactants having the formula



wherein R^3 is an alkyl, hydroxyalkyl, or alkyl phenyl group or mixtures thereof containing from about 8 to about 22 carbon atoms; R^4 is an alkylene or hydroxyalkylene group containing from 2 to 3 carbon atoms or mixtures thereof; x is from 0 to about 3; and each R^5 is an alkyl or hydroxyalkyl group containing from 1 to about 3

carbon atoms or a polyethylene oxide group containing from one to about 3 ethylene oxide groups. The R⁵ groups can be attached to each other, e.g., through an oxygen or nitrogen atom to form a ring structure.

5 Preferred amine oxide detergent surfactants are C₁₀-C₁₈ alkyl dimethyl amine oxide and C₈-C₁₂ alkoxy ethyl dihydroxy ethyl amine oxide.

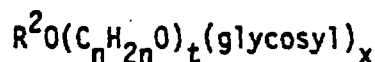
6. Alkylpolysaccharides disclosed in EP-A-0070074 having a
10 hydrophobic group containing from about 6 to about 30 carbon atoms, preferably from about 10 to about 16 carbon atoms and a polysaccharide, e.g., a polyglycoside, hydrophilic group containing from about 1½ to about 10, preferably from about 1½ to about 3, most preferably from about 1.6 to about 2.7 saccharide
15 units. Any reducing saccharide containing 5 or 6 carbon atoms can be used, e.g. glucose, galactose and galactosyl moieties can be substituted for the glucosyl moieties. (Optionally the hydrophobic group is attached at the 2, 3, 4, etc. positions thus giving a glucose or galactose as opposed to a glucoside or galactoside.) The intersaccharide bonds can be, e.g., between the one
20 position of the additional saccharide units and the 2-, 3-, 4-, and/or 6 positions on the preceding saccharide units.

Optionally, and less desirably, there can be a polyalkylene-oxide chain joining the hydrophobic moiety and the polysaccharide
25 moiety. The preferred alkyleneoxide is ethylene oxide. Typical hydrophobic groups include alkyl groups, either saturated or unsaturated, branched or unbranched containing from about 8 to about 18, preferably from about 10 to about 16, carbon atoms. Preferably, the alkyl group is a straight chain saturated alkyl
30 group. The alkyl group can contain up to 3 hydroxy groups and/or the polyalkyleneoxide chain can contain up to about 10, preferably less than 5, most preferably 0, alkyleneoxide moieties. Suitable alkyl polysaccharides are octyl, nonyldecyl, undecyldodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, and
35 octadecyl, di-, tri-, tetra-, penta-, and hexagluco-sides, galactosides, lactosides, glucoses, fructosides, fructoses, and/or

galactoses. Suitable mixtures include coconut alkyl, di-, tri-, tetra-, and pentagluco-sides and tallow alkyl tetra-, penta-, and hexagluco-sides.

The preferred alkylpolyglycosides have the formula

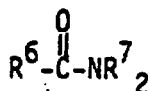
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wherein R^2 is selected from the group consisting of alkyl, alkyl-phenyl, hydroxyalkyl, hydroxyalkylphenyl, and mixtures thereof in which the alkyl groups contain from about 10 to about 18, preferably from about 12 to about 14, carbon atoms; n is 2 or 3, preferably 2; t is from 0 to about 10, preferably 0; and x is from $1\frac{1}{2}$ to about 10, preferably from about $1\frac{1}{2}$ to about 3, most preferably from about 1.6 to about 2.7. The glycosyl is preferably derived from glucose. To prepare these compounds, the alcohol or alkyl-polyethoxy alcohol is formed first and then reacted with glucose, or a source of glucose, to form the glucoside (attachment at the 1-position). The additional glycosyl units can then be attached between their 1-position and the preceding glycosyl units 2-, 3-, 4- and/or 6- position, preferably predominately the 2-position.

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7. Fatty acid amide detergent surfactants having the formula:



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wherein R^6 is an alkyl group containing from about 7 to about 21 (preferably from about 9 to about 17) carbon atoms and each R^7 is selected from the group consisting of hydrogen, C_1 - C_4 alkyl, C_1 - C_4 hydroxyalkyl, and $-(C_2H_4O)_xH$ where x varies from about 1 to about 3.

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Preferred amides are C_8 - C_{20} ammonia amides, monoethanol-amides, diethanolamides, and isopropanol amides.

B. Anionic Surfactants

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Anionic surfactants suitable in detergent compositions of the present invention are generally disclosed in U.S. Patent 3,929,678

to Laughlin et al., issued December 30, 1975 at column 23, line 58 through column 29, line 23,

Classes of anionic surfactants included are:

1. Ordinary alkali metal soaps such as the sodium, potassium, ammonium and alkylammonium salts of higher fatty acids containing from about 8 to about 24 carbon atoms, preferably from about 10 to about 20 carbon atoms.

2. Water-soluble salts, preferably 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 anionic surfactants are the sodium and potassium alkyl sulfates, especially those obtained by sulfating the higher alcohols (C_8 - 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 9 to about 15 carbon atoms, in straight chain or branched chain configuration, e.g., those of the type described in U.S. Patents 2,220,099 and 2,477,383. Especially valuable are linear straight chain alkylbenzene sulfonates in which the average number of carbon atoms in the alkyl group is from about 11 to 13, abbreviated as C_{11} - C_{13} LAS.

Preferred anionic surfactants of this type are the alkyl polyethoxylate sulfates, particularly those in which the alkyl group contains from about 10 to about 22, preferably from about 12 to about 18 carbon atoms, and wherein the polyethoxylate chain contains from about 1 to about 15 ethoxylate moieties preferably from about 1 to about 3 ethoxylate moieties. These anionic detergent surfactants are particularly desirable for formulating heavy-duty liquid laundry detergent compositions.

Other anionic surfactants of this type include 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 phenol 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.

Also included are 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-acyloxy-alkane-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; alkyl ether sulfates containing from about 10 to 20 carbon atoms in the alkyl group and from about 1 to 30 moles of ethylene oxide; water-soluble salts of olefin sulfonates containing from about 12 to 24 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.

- 3. Anionic phosphate surfactants.
- 4. N-alkyl substituted succinamates.

C. Ampholytic Surfactants

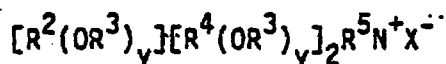
Ampholytic surfactants can be broadly described as aliphatic derivatives of secondary or tertiary amines, or aliphatic derivatives of heterocyclic secondary and tertiary amines in which the aliphatic radical can be straight chain or branched and wherein one of the aliphatic substituents contains from about 8 to 18 carbon atoms and at least one contains an anionic water-solubilizing group, e.g. carboxy, sulfonate, sulfate. See U.S. Patent 3,929,678 to Laughlin et al., issued December 30, 1975 at column 19, lines 18-35 for examples of ampholytic surfactants.

D. Zwitterionic Surfactants

Zwitterionic surfactants can be broadly described as derivatives of secondary and tertiary amines, derivatives of heterocyclic secondary and tertiary amines, or derivatives of quaternary ammonium, quaternary phosphonium or tertiary sulfonium compounds. See U.S. Patent 3,929,678 to Laughlin et al., issued December 30, 1975 at column 19, line 38 through column 22, line 48 for examples of zwitterionic surfactants.

E. Cationic Surfactants

Cationic surfactants can also be included in detergent compositions of the present invention. Suitable cationic surfactants include the quaternary ammonium surfactants having the formula:



wherein R^2 is an alkyl or alkyl benzyl group having from about 8 to about 18 carbon atoms in the alkyl chain; each R^3 is selected from the group consisting of $-CH_2CH_2-$, $-CH_2CH(CH_3)-$, $-CH_2CH(CH_2OH)-$, $-CH_2CH_2CH_2-$, and mixtures thereof; each R^4 is selected from the group consisting of C_1-C_4 alkyl, C_1-C_4 hydroxyalkyl, benzyl, ring structures formed by joining the two R^4 groups, $-CH_2CHOHCHOHCOR^6CHOHCH_2OH$ wherein R^6 is any hexose or hexose polymer having a molecular weight less than about 1000, and hydrogen when y is not 0; R^5 is the same as R^4 or is an alkyl chain wherein the total number of carbon atoms of R^2 plus R^5 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.

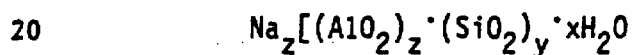
Preferred of the above are the alkyl quaternary ammonium surfactants, especially the mono-long chain alkyl surfactants described in the above formula when R^5 is selected from the same groups as R^4 . The most preferred quaternary ammonium surfactants are the chloride, bromide and methylsulfate C_8-C_{16} alkyl trimethylammonium salts, C_8-C_{16} alkyl di(hydroxyethyl)methylammonium salts, the C_8-C_{16} alkyl hydroxyethyldimethylammonium salts, and

5 C_8-C_{16} alkyloxypropyl trimethylammonium salts. Of the above, decyl trimethylammonium methylsulfate, lauryl trimethylammonium chloride, myristyl trimethylammonium bromide and coconut trimethylammonium chloride and methylsulfate are particularly preferred.

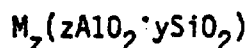
Detergent Builders

Detergent compositions of the present invention can optionally comprise inorganic or organic detergent builders to assist in mineral hardness control. These builders can comprise from 0 to 80% by weight of the composition. When included, these builders typically comprise up to 60% by weight of the detergent composition. Built liquid formulations preferably comprise from 10 to 25% detergent builder while built granular formulations preferably comprise from 10 to 50% by weight detergent builder.

Suitable detergent builders include crystalline aluminosilicate ion exchange materials having the formula:



wherein z and y are at least about 6, the mole ratio of z to y is from about 1.0 to about 0.5; and x is from about 10 to about 264. Amorphous hydrated aluminosilicate materials useful herein have the empirical formula



wherein M is sodium, potassium, ammonium or substituted ammonium, z is from about 0.5 to about 2; and y is 1; this material having a magnesium ion exchange capacity of at least about 50 milligram equivalents of $CaCO_3$ hardness per gram of anhydrous aluminosilicate.

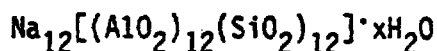
The aluminosilicate ion exchange builder materials are in hydrated form and contain from about 10% to about 28% of water by weight if crystalline, and potentially even higher amounts of

water, if amorphous. Highly preferred crystalline aluminosilicate ion exchange materials contain from about 18% to about 22% water in their crystal matrix. The preferred crystalline aluminosilicate ion exchange materials are further characterized by a particle size diameter of from about 0.1 micron to about 10 microns. Amorphous materials are often smaller, e.g., down to less than about 0.01 micron. More preferred ion exchange materials have a particle size diameter of from about 0.2 micron to about 4 microns. The term "particle size diameter" represents the average particle size diameter of a given ion exchange material as determined by conventional analytical techniques such as, for example, microscopic determination utilizing a scanning electron microscope. The crystalline aluminosilicate ion exchange materials are usually further characterized by their calcium ion exchange capacity, which is at least about 200 mg. equivalent of CaCO_3 water hardness/g. of aluminosilicate, calculated on an anhydrous basis, and which generally is in the range of from about 300 mg. eq./g. to about 352 mg. eq./g. The aluminosilicate ion exchange materials are still further characterized by their calcium ion exchange rate which is at least about 2 grains Ca^{++} /gallon/minute/gram/gallon of aluminosilicate (anhydrous basis), and generally lies within the range of from about 2 grains/gallon/minute/gram/gallon to about 6 grains/gallon/minute/gram/gallon, based on calcium ion hardness. Optimum aluminosilicates for builder purposes exhibit a calcium ion exchange rate of at least about 4 grains/gallon/minute/gram/gallon.

The amorphous aluminosilicate ion exchange materials usually have a Mg^{++} exchange capacity of at least about 50 mg. eq. CaCO_3 /g. (12 mg. Mg^{++} /g.) and a Mg^{++} exchange rate of at least about 1 grain/gallon/minute/gram/gallon. Amorphous materials do not exhibit an observable diffraction pattern when examined by Cu radiation (1.54 Angstrom Units).

Useful aluminosilicate ion exchange materials are commercially available. These aluminosilicates can be crystalline or amorphous in structure and can be naturally-occurring aluminosilicates or synthetically derived. A method for producing

aluminosilicate ion exchange materials is disclosed in U.S. Patent 3,985,669 to Krummel, et al. issued October 12, 1976 (herein incorporated by reference). Preferred synthetic crystalline aluminosilicate ion exchange materials useful herein are available
5 under the designations Zeolite A, Zeolite P (8), and Zeolite X. In an especially preferred embodiment, the crystalline aluminosilicate ion exchange material has the formula



10

wherein x is from about 20 to about 30, especially about 27.

Other examples of detergency builders include the various water-soluble, alkali metal, ammonium or substituted ammonium phosphates, polyphosphates, phosphonates, polyphosphonates,
15 carbonates, silicates, borates, polyhydroxysulfonates, polyacetates, carboxylates, and polycarboxylates. Preferred are the alkali metal, especially sodium, salts of the above.

Specific examples of inorganic phosphate builders are sodium and potassium tripolyphosphate, pyrophosphate, polymeric metaphate
20 having a degree of polymerization of from about 6 to 21, and orthophosphate. Examples of polyphosphonate builders are the sodium and potassium salts of ethylene-1,1-diphosphonic acid, the sodium and potassium salts of ethane 1-hydroxy-1,1-diphosphonic acid and the sodium and potassium salts of ethane, 1,1,2-triphosphonic acid. Other phosphorus builder compounds are disclosed in
25 U.S. Patents 3,159,581; 3,213,030; 3,422,021; 3,422,137; 3,400,176 and 3,400,148 (all herein incorporated by reference).

Examples of nonphosphorus, inorganic builders are sodium and potassium carbonate, bicarbonate, sesquicarbonate, tetraborate
30 decahydrate, and silicate having a mole ratio of SiO_2 to alkali metal oxide of from about 0.5 to about 4.0, preferably from about 1.0 to about 2.4.

Useful water-soluble, nonphosphorus organic builders include the various alkali metal, ammonium and substituted ammonium
35 polyacetates, carboxylates, polycarboxylates and polyhydroxysulfonates. Examples of polyacetate and polycarboxylate builders

are the sodium, potassium lithium, ammonium and substituted ammonium salts of ethylenediamine tetraacetic acid, nitrilotriacetic acid, oxydisuccinic acid, mellitic acid, benzene polycarboxylic acids, and citric acid.

- 5 Highly preferred polycarboxylate builders are disclosed in U.S. Patent No. 3,308,067 to Diehl, issued March 7, 1967.

Such materials include the water-soluble salts of homo- and copolymers of aliphatic carboxylic acids such as maleic acid, itaconic acid, mesaconic acid, fumaric
10 acid, aconitic acid, citraconic acid and methylenemalononic acid.

Other builders include the carboxylated carbohydrates disclosed in U.S. Patent 3,723,322 to Diehl issued March 28, 1973.

- Other useful builders are sodium and potassium carboxymethyloxymalonate, carboxymethyloxysuccinate, cis-cyclohexanehexacarboxylate, cis-cyclopentanetetracarboxylate phloroglucinol trisulfonate, water-soluble polyacrylates (having molecular weights of
15 from about 2,000 to about 200,000 for example), and the copolymers of maleic anhydride with vinyl methyl ether or ethylene.

- 20 Other suitable polycarboxylates are the polyacetal carboxylates disclosed in U.S. Patent 4,144,226, to Crutchfield et al. issued March 13, 1979, and U.S. Patent 4,246,495, to Crutchfield et al., issued March 27, 1979.

- These polyacetal carboxylates can be prepared by bringing
25 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 in alkaline solution, converted to the corresponding salt,
30 and added to a surfactant.

Other useful detergency builder materials are the "seeded builder" compositions disclosed in Belgian Patent No. 798,856, issued October 29, 1973.

- Specific examples of such seeded builder mixtures are: 3:1 wt.
35 mixtures of sodium carbonate and calcium carbonate having 5 micron particle diameter; 2.7:1 wt. mixtures of sodium sesquicarbonate

and calcium carbonate having a particle diameter of 0.5 microns; 20:1 wt. mixtures of sodium sesquicarbonate and calcium hydroxide having a particle diameter of 0.01 micron; and a 3:3:1 wt. mixture of sodium carbonate, sodium aluminate and calcium oxide having a particle diameter of 5 microns.

Other Optional Detergent Ingredients

Other optional ingredients which can be included in detergent compositions of the present invention, in their conventional art-established levels for use (i.e., from 0 to about 20%), include solvents, bleaching agents, bleach activators, soil-suspending agents, corrosion inhibitors, dyes, fillers, optical brighteners, germicides, pH adjusting agents (monoethanolamine, sodium carbonate, sodium hydroxide, etc.), enzymes, enzyme-stabilizing agents, perfumes, fabric softening components, static control agents, and the like.

Detergent Formulations

Granular formulations embodying the detergent compositions of the present invention can be formed by conventional techniques, i.e., by slurring the individual components in water and then atomizing and spray-drying the resultant mixture, or by pan or drum granulation of the ingredients. Granular formulations preferably comprise from 10 to 30% detergent surfactant, usually anionic.

Liquid formulations embodying the detergent compositions can be built or unbuilt. If unbuilt, these compositions conventionally contain approximately 15 to 50% total surfactant, from 0 to 10% of an organic base such as a mono-, di-, or tri-alkanol amine, a neutralization system such as an alkali metal hydroxide and a lower primary alcohol such as ethanol or isopropanol, and approximately 20 to 80% water. Such compositions are normally homogeneous single phase liquids of low viscosity (approximately 100 to 150 centipoise at 75°F).

Built liquid detergent compositions can be in the form of single phase liquids provided that the builder is solubilized in

the mixture at its level of use. Such liquids conventionally contain 10 to 25% total surfactant, 10 to 25% builder which can be organic or inorganic, 3 to 10% of a hydrotrope system and 40 to 77% water. Liquids of this type also have a low viscosity (100 to 150 centipoise at 75°F). Built liquid detergents incorporating components that form heterogeneous mixtures (or levels of builder that cannot be completely dissolved) can also comprise detergent compositions of the present invention. Such liquids conventionally employ viscosity modifiers to produce systems having plastic shear characteristics to maintain stable dispersions and to prevent phase separation or solid settlement.

Near Neutral Wash pH Detergent Formulations

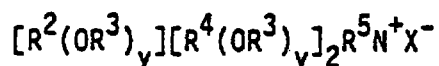
While the detergent compositions of the present invention are operative within a wide range of wash pHs (e.g. from about 5 to about 12), they are particularly suitable when formulated to provide a near neutral wash pH, i.e. an initial pH of from about 6.0 to about 8.5 at a concentration of from about 0.1 to about 2% by weight in water at 20°C. Near neutral wash pH formulations are better for enzyme stability and for preventing stains from setting. In such formulations, the wash pH is preferably from about 7.0 to about 8.5, and more preferably from about 7.5 to about 8.0.

Preferred near neutral wash pH detergent formulations are disclosed in EP-A-0095205. These preferred formulations comprise:

(a) from about 2 to about 60% (preferably from about 10 to about 25%) by weight of an anionic synthetic surfactant as previously defined;

(b) from about 0.25 to about 12% (preferably from about 1 to about 4%) by weight of a cosurfactant selected from the group consisting of:

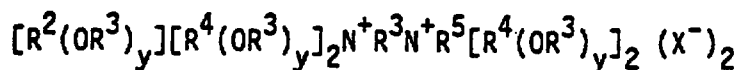
(i) quaternary ammonium surfactants having the formula:



wherein R^2 , each R^3 , R^4 , R^5 , X and y are as previously defined;

(ii) diquatary ammonium surfactants having the formula:

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wherein R^2 , R^3 , R^4 , y and X are as defined above; particularly preferred are the C_8 - C_{16} alkyl pentamethylethylenediamine chloride, bromide and methylsulfate salts;

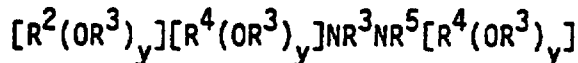
(iii) amine surfactants having the formula:



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wherein R^2 , R^3 , R^4 , R^5 and y are as defined above; particularly preferred are the C_{12} - C_{16} alkyl dimethyl amines;

(iv) diamine surfactants having the formula:

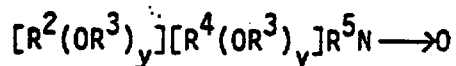


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wherein R^2 , R^3 , R^4 , R^5 and y are as defined above; particularly preferred are the C_{12} - C_{16} alkyl dimethyl diamines;

(v) amine oxide surfactants having the formula:

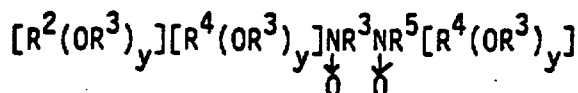
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wherein R^2 , R^3 , R^4 , R^5 and y are as defined above; particularly preferred are the C_{12} - C_{16} alkyl dimethyl amine oxides; and

30

(vi) di(amine oxide) surfactants having the formula:



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wherein R^2 , R^3 , R^4 , R^5 and y are as defined above; preferred are the C_{12} - C_{16} alkyl trimethylethylene di(amine oxides) and

(c) from about 5% to about 40% by weight (preferably 7 to about 30% by weight, and most preferably from about 10 to 20% by weight) of a fatty acid containing from about 10 to about 22 carbon atoms (preferably a C₁₀-C₁₄ saturated fatty acid or mixture thereof); the mole ratio of the anionic surfactant to the cosurfactant being at least 1 and preferably from about 2:1 to about 20:1.

Such compositions also preferably contain from about 3 to about 15% by weight of an ethoxylated alcohol or ethoxylated alkyl phenol (nonionic surfactants) as previously defined. Highly preferred compositions of this type also preferably contain from about 2 to about 10% by weight of citric acid and minor amounts (e.g., less than about 20% by weight) of neutralizing agents, buffering agents, phase regulants, hydrotropes, enzymes, enzyme stabilizing agents, polyacids, suds regulants, opacifiers, antioxidants, bactericides, dyes, perfumes and brighteners, such as those described in U.S. Patent 4,285,841 to Barrat et al., issued August 25, 1981 (herein incorporated by reference).

Specific Embodiments of Detergent Compositions

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According to the Present Invention

The following embodiments illustrate, but are not limiting of, detergent compositions of the present invention:

A granular detergent composition is as follows:

<u>Component</u>	<u>Wt. %</u>
Ethoxylated amine of Example 1	1.0
Sodium C ₁₄ -C ₁₅ alkylethoxysulfate	10.7
C ₁₃ linear alkyl benzene sulfonic acid	4.3
C ₁₂ -C ₁₄ alkylpolyethoxylate (6)	0.5
Sodium toluene sulfonate	1.0
Sodium tripolyphosphate	32.9
Sodium carbonate	20.3
Sodium silicate	5.8
Minors and water	Balance to 100

The components are added together with continuous mixing to form an aqueous slurry which is then spray dried to form the composition.

Embodiment II

... A liquid detergent composition is as follows:

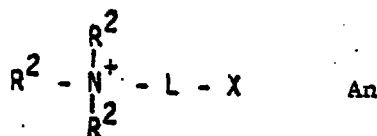
	<u>Component</u>	<u>Wt. %</u>
	Ethoxylated amine of Example 1	1.0
5	Sodium C ₁₂ alkylpolyethoxy (3) sulfate	12.6
	C ₁₂ -C ₁₃ alcohol polyethoxylate (6.5)	23.4
	Monoethanolamine	2.0
	Ethanol	9.0
	Citric acid monohydrate	0.8
10	Minors and water	Balance to 100

The components are added together with continuous mixing to form the composition.

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CLAIMS

1. A detergent composition comprising:
 - (a) from 1% to 75% by weight of a nonionic, anionic, ampholytic, zwitterionic, or cationic detergent surfactant or mixtures thereof;
 - (b) from 0.05 to 95% by weight of a water-soluble cationic compound having clay soil removal/anti-redeposition properties selected from ethoxylated cationic monoamines having the formula:



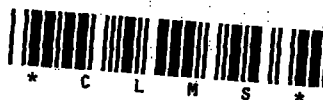
wherein each R^2 is C_1 - C_4 alkyl or hydroxyalkyl, the moiety $-L-X$, or two R^2 together form the moiety $-(CH_2)_r-A^2-(CH_2)_s-$, wherein A^2 is $-O-$ or $-CH_2-$, r is 1 or 2, s is 1 or 2 and $r + s$ is 3 or 4; X is a nonionic group selected from H , C_1 - C_4 alkyl or hydroxyalkyl ester or C_1 - C_4 alkyl or hydroxyalkyl ether groups; L is a hydrophilic chain consisting of the polyoxyalkylene moiety $-[(R^6O)_m(CH_2CH_2O)_n]-$, wherein R^6 is C_3 - C_4 alkylene or hydroxyalkylene, n is a number of at least 12 such that the moiety $-(CH_2CH_2O)_n-$ comprises at least 50% by weight of said polyoxyalkylene moiety; m is from 0 to 5; and An represents an equivalent number of counteranions; and optionally

- (c) up to 80% by weight of a detergent builder.
2. The composition of Claim 1 characterized in that one R^2 is methyl and two R^2 are the moiety $L-X$.
3. The composition of Claim 2 characterized in that m is 0 and n is at least 15.



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4. The composition of any of Claims 1 to 3 characterized in that it comprises from 0.1 to 10% by weight of said cationic compound.
 5. The composition of Claim 4 characterized in that it comprises from 1 to 3% by weight of said cationic compound.
 6. The composition of any of Claims 4-5 characterized in that said detergent surfactant is selected from nonionic surfactants, anionic surfactants or mixtures thereof.
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* C L M S *