



- (72) ASANO, Kaori, JP
- (72) SCHEIBEL, Jeffrey John, US
- (72) MINAMIKAWA, Kaori, JP
- (72) CRON, Laura, US
- (72) WILLMAN, Kenneth William, US
- (72) CRIPE, Thomas Anthony, US
- (72) CURRY, John Downing, US
- (72) DODD, Ian Martin, GB
- (72) HARTSHORN, Richard Timothy, GB
- (72) THOEN, Christiaan Arthur Jacques Kamiel, BE
- (72) KATSUDA, Rinko, JP
- (72) KVIETOK, Frank Andrej, US
- (72) MAO, Mark Hsiang-Kuen, JP
- (72) MOSS, Michael Alan John, GB
- (72) MURATA, Susumu, JP
- (72) FOLEY, Peter Robert, US
- (72) PANANDIKER, Rajan Keshav, US
- (72) PRAMOD, Kakumanu, US
- (72) SARNAIK, Khizar Mohammed Khan, JP
- (72) MANOHAR, Sanjeev Krishnadas, US
- (71) THE PROCTER & GAMBLE COMPANY, US
- (51) Int.Cl.<sup>6</sup> C11D 1/62, C11D 1/65, C11D 3/39, C11D 3/04
- (30) 1996/05/17 (60/017,886) US
- (54) **COMPOSITION DETERGIVE**
- (54) **DETERGENT COMPOSITION**

(57) L'invention concerne une composition détergitive constituée d'un agent de blanchiment peroxyde, d'un agent de blanchiment catalytique, d'un tensioactif non composé d'ammonium quaternaire alcoxylé et d'un tensioactif cationique d'ammonium quaternaire alcoxylé (AQA).

(57) Detergent composition comprising peroxygen bleach, a bleach catalyst, a non-AQA surfactant and an alkoxylated quaternary ammonium (AQA) cationic surfactant.



PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>6</sup> :</b> <b>C11D 3/39, 1/65, 3/02, 17/00 // C11D</b> <b>1:02, 1:62</b>	<b>A3</b>	<b>(11) International Publication Number:</b> <b>WO 97/43391</b> <b>(43) International Publication Date:</b> 20 November 1997 (20.11.97)
<b>(21) International Application Number:</b> PCT/US97/08442 <b>(22) International Filing Date:</b> 16 May 1997 (16.05.97) <b>(30) Priority Data:</b> 60/017,886                      17 May 1996 (17.05.96)                      US <b>(71) Applicant (for all designated States except US):</b> THE PROCTER & GAMBLE COMPANY [US/US]; One Procter & Gamble Plaza, Cincinnati, OH 45202 (US). <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only):</b> ASANO, Kaori [JP/JP]; Ohgi, 5-16-1-207, Higashinada-ku, Kobe, Hyogo (JP). SCHEIBEL, Jeffrey, John [US/US]; 10400 Buxton Lane, Montgomery, OH 45242-5306 (US). MINAMIKAWA, Kaori [JP/JP]; 1-26-46, Mitachi-Higashi, Himeji, Hyogo 670 (JP). CRON, Laura [US/US]; 5656 Lake Mead Drive, Fairfield, OH 45202 (US). WILLMAN, Kenneth, William [US/US]; 5603 Williamsburg Way, Fairfield, OH 45014 (US). CRIFE, Thomas, Anthony [US/US]; 599 Three Chimneys Lane, Loveland, OH 45140 (US). CURRY, John, Downing [US/US]; 95 Stone Creek Drive, Oxford, OH 45056 (US). DODD, Ian, Martin [GB/GB]; 47 Holywell Drive, Loughborough LE11 3JU (GB). HARTSHORN, Richard, Timothy [GB/GB]; 139 Dene Road, Wylam,	Northumberland NE41 8EY (GB). THOEN, Christiaan, Arthur, Jacques, Kamiel [BE/BE]; Boekweithofstraat 4, B-9120 Haasdonk (BE). KATSUDA, Rinko [JP/JP]; Kobe Park City C507, 6-2-1, Chuo-ku, Kobe 650 (JP). KVIETOK, Frank, Andrej [US/US]; 1103 Richwood Avenue, Cincinnati, OH 45208 (US). MAO, Mark, Hsiang-Kuen [JP/JP]; 2-23-13, Honmachi, Sumiyoshi, Kobe 658 (JP). MOSS, Michael, Alan, John [GB/GB]; 13 Painshawfield Road, Stocksfield, Northumberland NE43 7DZ (GB). MURATA, Susumu [JP/JP]; 6-5-A3, Yuba-cho, Nishinomiya-City, Hyogo 662 (JP). FOLEY, Peter, Robert [GB/US]; Apartment 906, One Lytle Place, Cincinnati, OH 45202 (US). PANANDIKER, Rajan, Keshav [US/US]; 6484 Oregon Pass, West Chester, OH 45069 (US). PRAMOD, Kakumanu [IN/US]; 7986 Kingfisher Lane, West Chester, OH 45069 (US). SARNAIK, Khizar, Mohamed, Khan [IN/JP]; 5-1-523-302, Koyo-cho Naka, Kobe 658 (JP). MANOHAR, Sanjeev, Krishnadas [US/US]; 2014 B Meadowlawn Way, Fairfield, OH 45014 (US). <b>(74) Agents:</b> REED, T., David et al.; The Procter & Gamble Company, 5299 Spring Grove Avenue, Cincinnati, OH 45217 (US). <b>(81) Designated States:</b> BR, CA, CN, JP, MX, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). <b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i> <b>(88) Date of publication of the international search report:</b> 24 December 1997 (24.12.97)	
<b>(54) Title:</b> DETERGENT COMPOSITION		
<b>(57) Abstract</b> <p>Detergent composition comprising peroxygen bleach, a bleach catalyst, a non-AQA surfactant and an alkoxyated quaternary ammonium (AQA) cationic surfactant.</p>		

## DETERGENT COMPOSITION

### Technical Field

The present invention relates to a detergent composition comprising a peroxygen bleach, a metal-containing bleach catalyst a non-AQA surfactant and an alkoxyated quaternary ammonium (AQA) cationic surfactant.

### Background to the Invention

The formulation of laundry detergents and other cleaning compositions presents a considerable challenge, since modern compositions are required to remove a variety of soils and stains from diverse substrates. Thus, laundry detergents, hard surface cleaners, shampoos and other personal cleansing compositions, hand dishwashing detergents and detergent compositions suitable for use in automatic dishwashers all require the proper selection and combination of ingredients in order to function effectively. In general, such detergent compositions will contain one or more types of surfactants which are designed to loosen and remove different types of soils and stains. While a review of the literature would seem to indicate that a wide selection of surfactants and surfactant combinations are available to the detergent manufacturer, the reality is that many such ingredients are specialty chemicals which are not suitable in low unit cost items such as home-use laundry detergents. The fact remains that most such home-use products such as laundry detergents still mainly comprise one or more of the conventional ethoxylated nonionic and/or sulfated or sulfonated anionic surfactants, presumably due to economic considerations and the need to formulate compositions which function reasonably well with a variety of soils and stains and a variety of fabrics.

The quick and efficient removal of different types of soils and stains such as body soils, greasy/oily soils and certain food stains, can be problematic. Such soils comprise a mixture of hydrophobic triglycerides, lipids, complex polysaccharides, inorganic salts and proteinaceous matter and are thus notoriously difficult to remove. Low levels of hydrophobic soils and residual stains often remain on the surface of the fabric after washing. Successive washing and wearing coupled with limited hydrophobic soil removal in the wash culminates in a build up of residual soil and stain which further

entraps particulate dirt leading to fabric yellowing. Eventually the fabric takes on a dingy appearance which is perceived as unwearable and discarded by the consumer.

The literature suggests that various nitrogen-containing cationic surfactants would be useful in a variety of cleaning compositions. Such materials, typically in the form of amino-, amido-, or quaternary ammonium or imidazolinium compounds, are often designed for specialty use. For example, various amino and quaternary ammonium surfactants have been suggested for use in shampoo compositions and are said to provide cosmetic benefits to hair. Other nitrogen-containing surfactants are used in some laundry detergents to provide a fabric softening and anti-static benefit. For the most part, however, the commercial use of such materials has been limited by the difficulty encountered in the large scale manufacture of such compounds. An additional limitation has been the potential precipitation of anionic active components of the detergent composition occasioned by their ionic interaction with cationic surfactants. The aforementioned nonionic and anionic surfactants remain the major surfactant components in today's laundry compositions.

It has now been discovered that certain bis-alkoxylated quaternary ammonium (AQA) compounds can be used in various detergent compositions to boost detergency performance on a variety of soil and stain types, particularly the hydrophobic soil types, commonly encountered. Unexpectedly, it has now been discovered that compositions containing AQA surfactants, peroxygen bleach and a metal-containing bleach catalyst deliver superior cleaning and whiteness performance versus products containing the technologies alone.

The AQA surfactants of the present invention provide substantial benefits to the formulator, over cationic surfactants previously known. For example, the AQA surfactants used herein provide marked improvement in cleaning of "everyday" greasy/oily hydrophobic soils regularly encountered. Moreover, the AQA surfactants are compatible with anionic surfactants commonly used in detergent compositions such as alkyl sulfate and alkyl benzene sulfonate; incompatibility with anionic components of the detergent composition has commonly been the limiting factor in the use of cationic surfactants previously known. Low levels (as low as 3 ppm in the laundering liquor) of AQA surfactants gives rise to the benefits described herein. AQA surfactants can be formulated over a broad pH range from 5 to 12. The AQA surfactants can be prepared as 30% (wt.) solutions which are pumpable, and therefore easy to handle in a

manufacturing plant. AQA surfactants with degrees of ethoxylation above 5 are sometimes present in a liquid form and can therefore be provided as 100% neat materials. In addition to their beneficial handling properties, the availability of AQA surfactants as highly concentrated solutions provides a substantial economic advantage in transportation costs. The AQA surfactants are also compatible with various perfume ingredients, unlike some cationic surfactants known in the art.

Bleach catalysts (characterized by the presence of at least one transition metal atom) interact with peroxide bleaching species to form very powerful hydrophilic bleaches. These bleaches deliver strong benefits on colored hydrophilic stains and hydrophilic everyday soils (i.e., socks). Historical use of bleach catalysts was made difficult because of concerns regarding fabric damage. It has now been found that fabric damage caused by using a dimanganese catalyst, known to cause fabric damage, can be much reduced when the detergent composition comprises an AQA cationic surfactant. It is proposed that these cationics adsorb onto fabrics, modifying the surface charge of the fabric and potentially ion-pairing with the activated catalyst to minimize or prevent fabric damage.

It is believed that the greasy/oily soils are effectively solubilized by an AQA, thereby allowing access of the hydrophilic catalyst bleach to the colour bodies in the soil (e.g. entrapped pigments) resulting in improved soil decolouration. The ability of the compositions described herein to clean both hydrophilic and hydrophobic soils results in superior cleaning and whiteness maintenance.

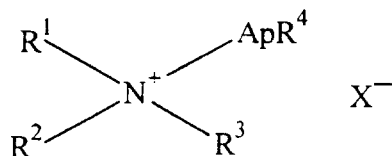
### **Background Art**

U.S. Patent 5,441,541, issued August 15, 1995, to A. Mehreteab and F. J. Loprest, relates to anionic/cationic surfactant mixtures. U.K. 2,040,990, issued 3 Sept., 1980, to A. P. Murphy, R.J.M. Smith and M. P. Brooks, relates to ethoxylated cationics in laundry detergents.

### **Summary of the Invention**

The present invention provides a composition comprising or prepared by combining a peroxygen bleach, a metal-containing bleach catalyst a non-AQA surfactant and an

effective amount of an alkoxyated quaternary ammonium (AQA) cationic surfactant of the formula:



wherein  $\text{R}^1$  is a linear, branched or substituted  $\text{C}_8$ - $\text{C}_{18}$  alkyl, alkenyl, aryl, alkaryl, ether or glyceryl ether moiety,  $\text{R}^2$  is a  $\text{C}_1$ - $\text{C}_3$  alkyl moiety,  $\text{R}^3$  and  $\text{R}^4$  can vary independently and are selected from hydrogen, methyl and ethyl, X is an anion, A is  $\text{C}_1$ - $\text{C}_4$  alkoxy and p is an integer in the range of from 2 to 30.

### Detailed Description of the Invention

#### Peroxygen Bleaching Agent

The detergent compositions herein comprise a peroxygen bleaching agent. Such bleaching agents are typically present at levels of from 1% to 30%, more typically from 5% to 20%, of the detergent composition, especially for fabric laundering.

Preferred peroxygen bleaches are perhydrate bleaches. The perhydrate bleach is normally incorporated in the form of the perhydrate salt, especially the sodium salt, at a level of from 1% to 40% by weight, more preferably from 2% to 30% by weight and most preferably from 5% to 25% by weight of the compositions.

Although the perhydrate bleach itself has some bleaching capability, a superior bleach exists in the peracid formed as a product of the reaction between the hydrogen peroxide released by the perhydrate and a bleach activator. Preformed peracids are also envisaged as a preferred peroxygen bleaching species.

Examples of suitable perhydrate salts include perborate, percarbonate, perphosphate, persulfate and persilicate salts. The preferred perhydrate salts are normally the alkali metal salts. The perhydrate salt may be included as the crystalline solid without additional protection. For certain perhydrate salts however, the preferred executions of such granular compositions utilize a coated form of the material which provides better storage stability for the perhydrate salt in the granular product.

Sodium perborate can be in the form of the monohydrate of nominal formula  $\text{NaBO}_2\text{H}_2\text{O}_2$  or the tetrahydrate  $\text{NaBO}_2\text{H}_2\text{O}_2 \cdot 3\text{H}_2\text{O}$ .

Alkali metal percarbonates, particularly sodium percarbonate are preferred perhydrates for inclusion in compositions in accordance with the invention. Sodium percarbonate is an addition compound having a formula corresponding to  $2\text{Na}_2\text{CO}_3 \cdot 3\text{H}_2\text{O}_2$ , and is available commercially as a crystalline solid. Sodium percarbonate, being a hydrogen peroxide addition compound tends on dissolution to release the hydrogen peroxide quite rapidly which can increase the tendency for localised high bleach concentrations to arise. The percarbonate is most preferably incorporated into such compositions in a coated form which provides in-product stability.

A suitable coating material providing in product stability comprises mixed salt of a water soluble alkali metal sulphate and carbonate. Such coatings together with coating processes have previously been described in GB-1,466,799, granted to Interlox on 9th March 1977. The weight ratio of the mixed salt coating material to percarbonate lies in the range from 1 : 200 to 1 : 4, more preferably from 1 : 99 to 1 : 9, and most preferably from 1 : 49 to 1 : 19. Preferably, the mixed salt is of sodium sulphate and sodium carbonate which has the general formula  $\text{Na}_2\text{SO}_4 \cdot n \cdot \text{Na}_2\text{CO}_3$  wherein n is from 0.1 to 3, preferably n is from 0.3 to 1.0 and most preferably n is from 0.2 to 0.5.

Other coatings which contain silicate (alone or with borate salts or boric acids or other inorganics), waxes, oils, fatty soaps can also be used advantageously within the present invention.

A preferred percarbonate bleach comprises dry particles having an average particle size in the range from 500 micrometers to 1,000 micrometers, not more than 10% by weight of said particles being smaller than 200 micrometers and not more than 10% by weight of said particles being larger than 1,250 micrometers.

Another suitable bleaching agent which can be used without restriction encompasses percarboxylic acid bleaching agents and salts thereof. Suitable examples of this class of agents include magnesium monoperoxyphthalate hexahydrate, the magnesium salt of metachloro perbenzoic acid, 4-nonylamino-4-oxoperoxybutyric acid and diperoxododecanedioic acid. Such bleaching agents are disclosed in U.S. Patent 4,483,781, Hartman, issued November 20, 1984, U.S. Patent Application 740,446, Burns et al, filed June 3, 1985, European Patent Application 0,133,354, Banks et al, published February 20, 1985, and U.S. Patent 4,412,934, Chung et al, issued November 1, 1983. Highly preferred bleaching agents also include 6-nonylamino-6-oxoperoxypropionic acid as described in U.S. Patent 4,634,551, issued January 6, 1987 to Burns et al. Potassium peroxymonopersulfate is another inorganic perhydrate salt of utility in the compositions herein.

Mixtures of bleaching agents are also envisaged.

#### Bleach Catalyst

The detergent compositions described herein comprise as an essential component a bleach catalyst. The catalysts are commonly present in extremely low levels in product, preferably from 0.001% to 5% by weight, more preferably from 0.01% to 2%, most preferably from 0.05% to 1%. Preferably the bleach catalyst is a metal-containing, more preferably a transition metal-containing bleach catalyst. The preferred transition metal-containing bleach catalysts are manganese or cobalt-containing bleach catalysts.

A suitable type of bleach catalyst is a catalyst comprising a heavy metal cation of defined bleach catalytic activity, such as copper, iron cations, an auxiliary metal cation having little or no bleach catalytic activity, such as zinc or aluminum cations, and a sequestrant having defined stability constants for the catalytic and auxiliary metal cations, particularly ethylenediaminetetraacetic acid, ethylenediaminetetra (methylenephosphonic acid) and water-soluble salts thereof. Such catalysts are disclosed in U.S. Pat. 4,430,243.

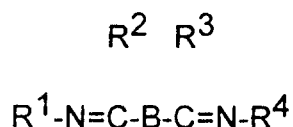
Preferred types of bleach catalysts include the manganese-based complexes disclosed in U.S. Pat. 5,246,621 and U.S. Pat. 5,244,594. Preferred examples of these catalysts include  $\text{Mn}^{\text{IV}}_2(\text{u-O})_3(1,4,7\text{-trimethyl-1,4,7-triazacyclononane})_2(\text{PF}_6)_2$ ,  $\text{Mn}^{\text{III}}_2(\text{u-O})_1(\text{u-OAc})_2(1,4,7\text{-trimethyl-1,4,7-triazacyclononane})_2(\text{ClO}_4)_2$ ,  $\text{Mn}^{\text{IV}}_4(\text{u-O})_6(1,4,7\text{-triazacyclononane})_4(\text{ClO}_4)_2$ ,  $\text{Mn}^{\text{III}}\text{Mn}^{\text{IV}}_4(\text{u-O})_1(\text{u-OAc})_2(1,4,7\text{-trimethyl-1,4,7-triazacyclononane})_2(\text{ClO}_4)_3$ , and mixtures thereof. Others are described in European patent application publication no. 549,272. Other ligands suitable for use herein include 1,5,9-trimethyl-1,5,9-triazacyclododecane, 2-methyl-1,4,7-triazacyclononane, 2-methyl-1,4,7-triazacyclononane, 1,2,4,7-tetramethyl-1,4,7-triazacyclononane, and mixtures thereof.

The bleach catalysts useful in the compositions herein may also be selected as appropriate for the present invention. For examples of suitable bleach catalysts see U.S. Pat. 4,246,612 and U.S. Pat. 5,227,084. See also U.S. Pat. 5,194,416 which teaches mononuclear manganese (IV) complexes such as  $\text{Mn}(1,4,7\text{-trimethyl-1,4,7-triazacyclononane})(\text{OCH}_3)_3(\text{PF}_6)$ .

Still another type of bleach catalyst, as disclosed in U.S. Pat. 5,114,606, is a water-soluble complex of manganese (III), and/or (IV) with a ligand which is a non-carboxylate polyhydroxy compound having at least three consecutive C-OH groups. Preferred ligands include sorbitol, iditol, dulcitol, mannitol, xylitol, arabitol, adonitol, meso-erythritol, meso-inositol, lactose, and mixtures thereof.



U.S. Pat. 5,114,611 teaches a bleach catalyst comprising a complex of transition metals, including Mn, Co, Fe, or Cu, with an non-(macro)-cyclic ligand. Said ligands are of the formula:



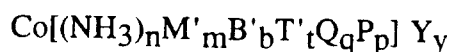
wherein  $R^1$ ,  $R^2$ ,  $R^3$ , and  $R^4$  can each be selected from H, substituted alkyl and aryl groups such that each  $R^1-N=C-R^2$  and  $R^3-C=N-R^4$  form a five or six-membered ring. Said ring can further be substituted. B is a bridging group selected from O, S,  $CR^5R^6$ ,  $NR^7$  and  $C=O$ , wherein  $R^5$ ,  $R^6$ , and  $R^7$  can each be H, alkyl, or aryl groups, including substituted or unsubstituted groups. Preferred ligands include pyridine, pyridazine, pyrimidine, pyrazine, imidazole, pyrazole, and triazole rings. Optionally, said rings may be substituted with substituents such as alkyl, aryl, alkoxy, halide, and nitro. Particularly preferred is the ligand 2,2'-bispyridylamine. Preferred bleach catalysts include Co, Cu, Mn, Fe, -bispyridylmethane and -bispyridylamine complexes. Highly preferred catalysts include  $Co(2,2'\text{-bispyridylamine})Cl_2$ , Di(isothiocyanato)bispyridylamine-cobalt (II), trisdipyridylamine-cobalt(II) perchlorate,  $Co(2,2'\text{-bispyridylamine})_2O_2ClO_4$ , Bis-(2,2'-bispyridylamine) copper(II) perchlorate, tris(di-2-pyridylamine) iron(II) perchlorate, and mixtures thereof.

Preferred examples include binuclear Mn complexes with tetra-N-dentate and bi-N-dentate ligands, including  $N_4Mn^{III}(u-O)_2Mn^{IV}N_4)^+$  and  $[Bipy_2Mn^{III}(u-O)_2Mn^{IV}bipy_2]-(ClO_4)_3$ .

While the structures of the bleach-catalyzing manganese complexes of the present invention have not been elucidated, it may be speculated that they comprise chelates or other hydrated coordination complexes which result from the interaction of the carboxyl and nitrogen atoms of the ligand with the manganese cation. Likewise, the oxidation state of the manganese cation during the catalytic process is not known with certainty, and may be the (+II), (+III), (+IV) or (+V) valence state. Due to the ligands' possible six points of attachment to the manganese cation, it may be reasonably speculated that multi-nuclear species and/or "cage" structures may exist in the aqueous bleaching media. Whatever the form of the active Mn-ligand species which actually exists, it functions in an apparently catalytic manner to provide improved bleaching performances on stubborn stains such as tea, ketchup, coffee, wine, juice.

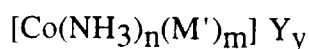
Other bleach catalysts are described, for example, in European patent application, publication no. 408,131 (cobalt complex catalysts), European patent applications, publication nos. 384,503, and 306,089 (metallo-porphyrin catalysts), U.S. 4,728,455 (manganese/multidentate ligand catalyst), U.S. 4,711,748 and European patent application, publication no. 224,952, (absorbed manganese on aluminosilicate catalyst), U.S. 4,601,845 (aluminosilicate support with manganese and zinc or magnesium salt), U.S. 4,626,373 (manganese/ligand catalyst), U.S. 4,119,557 (ferric complex catalyst), German Pat. specification 2,054,019 (cobalt chelant catalyst) Canadian 866,191 (transition metal-containing salts), U.S. 4,430,243 (chelants with manganese cations and non-catalytic metal cations), and U.S. 4,728,455 (manganese gluconate catalysts).

Other preferred examples include cobalt (III) catalysts having the formula:



wherein cobalt is in the +3 oxidation state; n is an integer from 0 to 5 (preferably 4 or 5; most preferably 5); M' represents a monodentate ligand; m is an integer from 0 to 5 (preferably 1 or 2; most preferably 1); B' represents a bidentate ligand; b is an integer from 0 to 2; T' represents a tridentate ligand; t is 0 or 1; Q is a tetradentate ligand; q is 0 or 1; P is a pentadentate ligand; p is 0 or 1; and  $n + m + 2b + 3t + 4q + 5p = 6$ ; Y is one or more appropriately selected counteranions present in a number y, where y is an integer from 1 to 3 (preferably 2 to 3; most preferably 2 when Y is a -1 charged anion), to obtain a charge-balanced salt, preferred Y are selected from the group consisting of chloride, nitrate, nitrite, sulfate, citrate, acetate, carbonate, and combinations thereof; and wherein further at least one of the coordination sites attached to the cobalt is labile under automatic dishwashing use conditions and the remaining coordination sites stabilize the cobalt under automatic dishwashing conditions such that the reduction potential for cobalt (III) to cobalt (II) under alkaline conditions is less than about 0.4 volts (preferably less than about 0.2 volts) versus a normal hydrogen electrode.

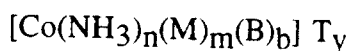
Preferred cobalt catalysts of this type have the formula:



wherein n is an integer from 3 to 5 (preferably 4 or 5; most preferably 5); M' is a labile coordinating moiety, preferably selected from the group consisting of chlorine, bromine, hydroxide, water, and (when m is greater than 1) combinations thereof; m is an integer from 1 to 3 (preferably 1 or 2; most preferably 1); m+n = 6; and Y is an appropriately selected counteranion present in a number y, which is an integer from 1 to 3 (preferably 2 to 3; most preferably 2 when Y is a -1 charged anion), to obtain a charge-balanced salt.

The preferred cobalt catalyst of this type useful herein are cobalt pentaamine chloride salts having the formula  $[\text{Co}(\text{NH}_3)_5\text{Cl}] \text{Y}_y$ , and especially  $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$ .

More preferred are the present invention compositions which utilize cobalt (III) bleach catalysts having the formula:

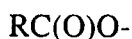


wherein cobalt is in the +3 oxidation state; n is 4 or 5 (preferably 5); M is one or more ligands coordinated to the cobalt by one site; m is 0, 1 or 2 (preferably 1); B is a ligand coordinated to the cobalt by two sites; b is 0 or 1 (preferably 0), and when b=0, then m+n = 6, and when b=1, then m=0 and n=4; and T is one or more appropriately selected counteranions present in a number y, where y is an integer to obtain a charge-balanced salt (preferably y is 1 to 3; most preferably 2 when T is a -1 charged anion); and wherein further said catalyst has a base hydrolysis rate constant of less than  $0.23 \text{ M}^{-1} \text{ s}^{-1}$  (25°C).

Preferred T are selected from the group consisting of chloride, iodide,  $\text{I}_3^-$ , formate, nitrate, nitrite, sulfate, sulfite, citrate, acetate, carbonate, bromide,  $\text{PF}_6^-$ ,  $\text{BF}_4^-$ ,  $\text{B}(\text{Ph})_4^-$ , phosphate, phosphite, silicate, tosylate, methanesulfonate, and combinations thereof. Optionally, T can be protonated if more than one anionic group exists in T, e.g.,  $\text{HPO}_4^{2-}$ ,  $\text{HCO}_3^-$ ,  $\text{H}_2\text{PO}_4^-$ , etc. Further, T may be selected from the group consisting of non-traditional inorganic anions such as anionic surfactants (e.g., linear alkylbenzene sulfonates (LAS), alkyl sulfates (AS), alkylethoxysulfonates (AES), etc.) and/or anionic polymers (e.g., polyacrylates, polymethacrylates, etc.).

The M moieties include, but are not limited to, for example,  $\text{F}^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{NCS}^-$ ,  $\text{SCN}^-$ ,  $\text{S}_2\text{O}_3^{2-}$ ,  $\text{NH}_3$ ,  $\text{PO}_4^{3-}$ , and carboxylates (which preferably are mono-carboxylates, but more than one carboxylate may be present in the moiety as long as the binding to the cobalt is by only one carboxylate per moiety, in which case the other carboxylate in the M moiety

may be protonated or in its salt form). Optionally, M can be protonated if more than one anionic group exists in M (e.g.,  $\text{HPO}_4^{2-}$ ,  $\text{HCO}_3^-$ ,  $\text{H}_2\text{PO}_4^-$ ,  $\text{HOC(O)CH}_2\text{C(O)O}^-$ , etc.) Preferred M moieties are substituted and unsubstituted  $\text{C}_1$ - $\text{C}_{30}$  carboxylic acids having the formulas:



wherein R is preferably selected from the group consisting of hydrogen and  $\text{C}_1$ - $\text{C}_{30}$  (preferably  $\text{C}_1$ - $\text{C}_{18}$ ) unsubstituted and substituted alkyl,  $\text{C}_6$ - $\text{C}_{30}$  (preferably  $\text{C}_6$ - $\text{C}_{18}$ ) unsubstituted and substituted aryl, and  $\text{C}_3$ - $\text{C}_{30}$  (preferably  $\text{C}_5$ - $\text{C}_{18}$ ) unsubstituted and substituted heteroaryl, wherein substituents are selected from the group consisting of  $-\text{NR}'_3$ ,  $-\text{NR}'_4^+$ ,  $-\text{C(O)OR}'$ ,  $-\text{OR}'$ ,  $-\text{C(O)NR}'_2$ , wherein R' is selected from the group consisting of hydrogen and  $\text{C}_1$ - $\text{C}_6$  moieties. Such substituted R therefore include the moieties  $-(\text{CH}_2)_n\text{OH}$  and  $-(\text{CH}_2)_n\text{NR}'_4^+$ , wherein n is an integer from 1 to about 16, preferably from about 2 to about 10, and most preferably from about 2 to about 5.

Most preferred M are carboxylic acids having the formula above wherein R is selected from the group consisting of hydrogen, methyl, ethyl, propyl, straight or branched  $\text{C}_4$ - $\text{C}_{12}$  alkyl, and benzyl. Most preferred R is methyl. Preferred carboxylic acid M moieties include formic, benzoic, octanoic, nonanoic, decanoic, dodecanoic, malonic, maleic, succinic, adipic, phthalic, 2-ethylhexanoic, naphthenoic, oleic, palmitic, triflate, tartrate, stearic, butyric, citric, acrylic, aspartic, fumaric, lauric, linoleic, lactic, malic, and especially acetic acid.

The B moieties include carbonate, di- and higher carboxylates (e.g., oxalate, malonate, malic, succinate, maleate), picolinic acid, and alpha and beta amino acids (e.g., glycine, alanine, beta-alanine, phenylalanine).

Cobalt bleach catalysts useful herein are known, being described for example along with their base hydrolysis rates, in M. L. Tobe, "Base Hydrolysis of Transition-Metal Complexes", *Adv. Inorg. Bioinorg. Mech.*, (1983), 2, pages 1-94. For example, Table 1 at page 17, provides the base hydrolysis rates (designated therein as  $k_{\text{OH}}$ ) for cobalt pentaamine catalysts complexed with oxalate ( $k_{\text{OH}} = 2.5 \times 10^{-4} \text{ M}^{-1} \text{ s}^{-1}$  (25°C)), NCS<sup>-</sup> ( $k_{\text{OH}} = 5.0 \times 10^{-4} \text{ M}^{-1} \text{ s}^{-1}$  (25°C)), formate ( $k_{\text{OH}} = 5.8 \times 10^{-4} \text{ M}^{-1} \text{ s}^{-1}$  (25°C)), and acetate ( $k_{\text{OH}} = 9.6 \times 10^{-4} \text{ M}^{-1} \text{ s}^{-1}$  (25°C)). The most preferred cobalt catalyst useful herein are cobalt pentaamine acetate salts having the formula  $[\text{Co}(\text{NH}_3)_5\text{OAc}] \text{ T}_y$ , wherein

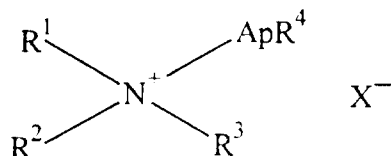
OAc represents an acetate moiety, and especially cobalt pentaamine acetate chloride,  $[\text{Co}(\text{NH}_3)_5\text{OAc}]\text{Cl}_2$ ; as well as  $[\text{Co}(\text{NH}_3)_5\text{OAc}](\text{OAc})_2$ ;  $[\text{Co}(\text{NH}_3)_5\text{OAc}](\text{PF}_6)_2$ ;  $[\text{Co}(\text{NH}_3)_5\text{OAc}](\text{SO}_4)$ ;  $[\text{Co}(\text{NH}_3)_5\text{OAc}](\text{BF}_4)_2$ ; and  $[\text{Co}(\text{NH}_3)_5\text{OAc}](\text{NO}_3)_2$  (herein "PAC").

These cobalt catalysts are readily prepared by known procedures, such as taught for example in the Tobe article hereinbefore and the references cited therein, in U.S. Patent 4,810,410, to Diakun et al, issued March 7, 1989, *J. Chem. Ed.* (1989), 66 (12), 1043-45; *The Synthesis and Characterization of Inorganic Compounds*, W.L. Jolly (Prentice-Hall: 1970), pp. 461-3; *Inorg. Chem.*, 18, 1497-1502 (1979); *Inorg. Chem.*, 21, 2881-2885 (1982); *Inorg. Chem.*, 18, 2023-2025 (1979); *Inorg. Synthesis*, 173-176 (1960); and *Journal of Physical Chemistry*, 56, 22-25 (1952); as well as the synthesis examples provided hereinafter.

As a practical matter, and not by way of limitation, the automatic dishwashing compositions and cleaning processes herein can be adjusted to provide on the order of at least one part per hundred million of the active bleach catalyst species in the aqueous washing medium, and will preferably provide from about 0.01 ppm to about 25 ppm, more preferably from about 0.05 ppm to about 10 ppm, and most preferably from about 0.1 ppm to about 5 ppm, of the bleach catalyst species in the wash liquor. In order to obtain such levels in the wash liquor of an automatic dishwashing process, typical automatic dishwashing compositions herein will comprise from about 0.0005% to about 0.2%, more preferably from about 0.004% to about 0.08%, of bleach catalyst, especially manganese or cobalt catalysts, by weight of the cleaning compositions.

#### Alkoxyated Quaternary Ammonium (AQA) Cationic Surfactant

The second essential component of the present invention comprises an effective amount of an AQA surfactant of the formula:



wherein  $\text{R}^1$  is a linear, branched or substituted alkyl, alkenyl, aryl, alkaryl, ether or glyceryl ether moiety containing from 8 to 18 carbon atoms, preferably 8 to 16 carbon atoms, most preferably from 8 to 14 carbon atoms;  $\text{R}^2$  and  $\text{R}^3$  are each independently

alkyl groups containing from 1 to 3 carbon atoms, preferably methyl;  $R^4$  is selected from hydrogen (preferred), methyl and ethyl,  $X^-$  is an anion such as chloride, bromide, methylsulfate, sulfate to provide electrical neutrality; A is selected from  $C_1$ - $C_4$  alkoxy, especially ethoxy (i.e.,  $-CH_2CH_2O-$ ), propoxy, butoxy and mixtures thereof; and p is an integer from 2 to 30, preferably 2 to 15, more preferably 2 to 8, most preferably 2 to 4.

AQA compounds wherein the hydrocarbyl substituent  $R^1$  is  $C_8$ - $C_{12}$  especially  $C_8$ - $C_{10}$ , enhance the rate of dissolution of laundry granules, especially under cold water conditions, as compared with the higher chain length materials. Accordingly, the  $C_8$ - $C_{12}$  AQA surfactants may be preferred by some formulators. The levels of the AQA surfactants used to prepare finished laundry detergent compositions can range from 0.1% to 5%, typically from 0.45% to 2.5%, by weight.

The present invention employs an "effective amount" of the AQA surfactants to improve the performance of cleaning compositions which contain other adjunct ingredients. By an "effective amount" of the AQA surfactants and adjunct ingredients herein is meant an amount which is sufficient to improve, either directionally or significantly at the 90% confidence level, the performance of the cleaning composition against at least some of the target soils and stains. Thus, in a composition whose targets include certain food stains, the formulator will use sufficient AQA to at least directionally improve cleaning performance against such stains. Likewise, in a composition whose targets include clay soil, the formulator will use sufficient AQA to at least directionally improve cleaning performance against such soil. Importantly, in a fully-formulated laundry detergent the AQA surfactants can be used at levels which provide at least a directional improvement in cleaning performance over a wide variety of soils and stains, as will be seen from the data presented hereinafter.

As noted, the AQA surfactants are used herein in detergent compositions in combination with other deterative surfactants at levels which are effective for achieving at least a directional improvement in cleaning performance. In the context of a fabric laundry composition, such "usage levels" can vary depending not only on the type and severity of the soils and stains, but also on the wash water temperature, the volume of wash water and the type of washing machine.

For example, in a top-loading, vertical axis U.S.-type automatic washing machine using 45 to 83 liters of water in the wash bath, a wash cycle of 10 to 14 minutes and a wash water temperature of 10°C to 50°C, it is preferred to include from 2 ppm to 50 ppm, preferably from 5 ppm to 25 ppm, of the AQA surfactant in the wash liquor. On the basis of usage rates of from 50 ml to 150 ml per wash load, this translates into an in-product concentration (wt.) of the AQA surfactant of from 0.1% to 3.2%, preferably 0.3% to 1.5%, for a heavy-duty liquid laundry detergent. On the basis of usage rates of from 60 g to 95 g per wash load, for dense ("compact") granular laundry detergents (density above 650 g/l) this translates into an in-product concentration (wt.) of the AQA surfactant of from 0.2% to 5.0%, preferably from 0.5% to 2.5%. On the basis of usage rates of from 80 g to 100 g per load for spray-dried granules (i.e., "fluffy"; density below 650 g/l), this translates into an in-product concentration (wt.) of the AQA surfactant of from 0.1% to 3.5%, preferably from 0.3% to 1.5%.

For example, in a front-loading, horizontal-axis European-type automatic washing machine using 8 to 15 liters of water in the wash bath, a wash cycle of 10 to 60 minutes and a wash water temperature of 30°C to 95°C, it is preferred to include from 13 ppm to 900 ppm, preferably from 16 ppm to 390 ppm, of the AQA surfactant in the wash liquor. On the basis of usage rates of from 45 ml to 270 ml per wash load, this translates into an in-product concentration (wt.) of the AQA surfactant of from 0.4% to 2.64%, preferably 0.55% to 1.1%, for a heavy-duty liquid laundry detergent. On the basis of usage rates of from 40 g to 210 g per wash load, for dense ("compact") granular laundry detergents (density above 650 g/l) this translates into an in-product concentration (wt.) of the AQA surfactant of from 0.5% to 3.5%, preferably from 0.7% to 1.5%. On the basis of usage rates of from 140 g to 400 g per load for spray-dried granules (i.e., "fluffy"; density below 650 g/l), this translates into an in-product concentration (wt.) of the AQA surfactant of from 0.13% to 1.8%, preferably from 0.18% to 0.76%.

For example, in a top-loading, vertical-axis Japanese-type automatic washing machine using 26 to 52 liters of water in the wash bath, a wash cycle of 8 to 15 minutes and a wash water temperature of 5°C to 25°C, it is preferred to include from 1.67 ppm to 66.67 ppm, preferably from 3 ppm to 6 ppm, of the AQA surfactant in the wash liquor. On the basis of usage rates of from 20 ml to 30 ml per wash load, this translates into an in-product concentration (wt.) of the AQA surfactant of from 0.25% to 10%, preferably 1.5% to 2%, for a heavy-duty liquid laundry detergent. On the basis of

usage rates of from 18 g to 35 g per wash load, for dense ("compact") granular laundry detergents (density above 650 g/l) this translates into an in-product concentration (wt.) of the AQA surfactant of from 0.25% to 10%, preferably from 0.5% to 1.0%. On the basis of usage rates of from 30 g to 40 g per load for spray-dried granules (i.e., "fluffy"; density below 650 g/l), this translates into an in-product concentration (wt.) of the AQA surfactant of from 0.25% to 10%, preferably from 0.5% to 1%.

As can be seen from the foregoing, the amount of AQA surfactant used in a machine-wash laundering context can vary, depending on the habits and practices of the user, the type of washing machine, and the like. In this context, however, one heretofore unappreciated advantage of the AQA surfactants is their ability to provide at least directional improvements in performance over a spectrum of soils and stains even when used at relatively low levels with respect to the other surfactants (generally anionics or anionic/nonionic mixtures) in the finished compositions. This is to be distinguished from other compositions of the art wherein various cationic surfactants are used with anionic surfactants at or near stoichiometric levels. In general, in the practice of this invention, the weight ratio of AQA:anionic surfactant in laundry compositions is in the range from 1:70 to 1:2, preferably from 1:40 to 1:6, more preferably from 1:30 to 1:6, most preferably from 1:15 to 1:8. In laundry compositions which comprise both anionic and nonionic surfactants, the weight ratio of AQA:mixed anionic/nonionic is in the range from 1:80 to 1:2, preferably 1:50 to 1:8.

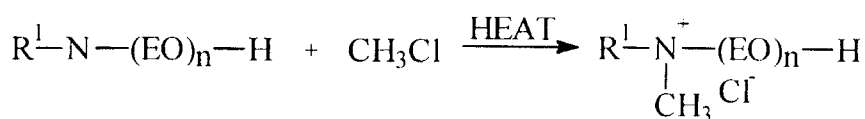
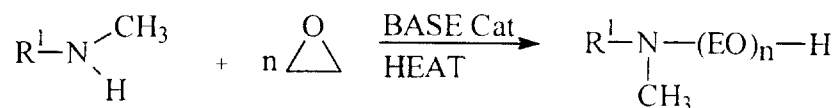
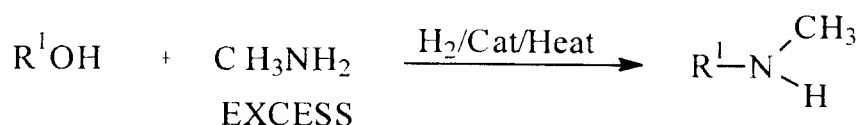
Various other cleaning compositions which comprise an anionic surfactant, an optional nonionic surfactant and specialized surfactants such as betaines, sultaines, amine oxides, and the like, can also be formulated using an effective amount of the AQA surfactants in the manner of this invention. Such compositions include, but are not limited to, hand dishwashing products (especially liquids or gels), hard surface cleaners, shampoos, personal cleansing bars, laundry bars, and the like. Since the habits and practices of the users of such compositions show minimal variation, it is satisfactory to include from 0.25% to 5%, preferably from 0.45% to 2%, by weight, of the AQA surfactants in such compositions. Again, as in the case of the granular and liquid laundry compositions, the weight ratio of the AQA surfactant to other surfactants present in such compositions is low, i.e., sub-stoichiometric in the case of anionics. Preferably, such cleaning compositions comprise AQA/surfactant ratios as noted immediately above for machine-use laundry compositions.



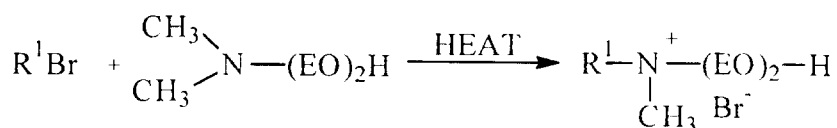
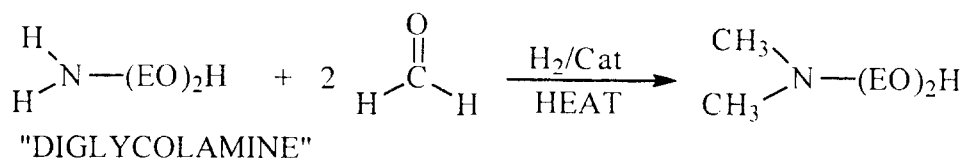
In contrast with other cationic surfactants known in the art, the alkoxyated cationics herein have sufficient solubility that they can be used in combination with mixed surfactant systems which are quite low in nonionic surfactants and which contain, for example, alkyl sulfate surfactants. This can be an important consideration for formulators of detergent compositions of the type which are conventionally designed for use in top loading automatic washing machines, especially of the type used in North America as well as under Japanese usage conditions. Typically, such compositions will comprise an anionic surfactant:nonionic surfactant weight ratio in the range from 25:1 to 1:25, preferably 20:1 to 3:1. This can be contrasted with European-type formulas which typically will comprise anionic:nonionic ratios in the range of 10:1 to 1:10, preferably 5:1 to 1:1.

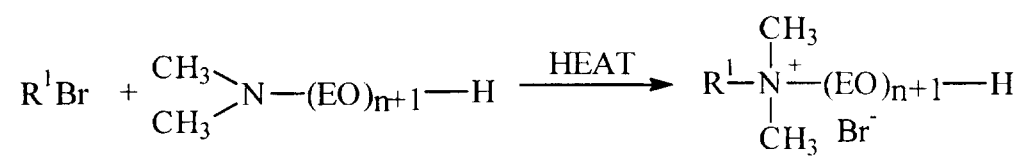
The preferred ethoxylated cationic surfactants herein can be synthesized using a variety of different reaction schemes (wherein "EO" represents -CH<sub>2</sub>CH<sub>2</sub>O- units), as follows.

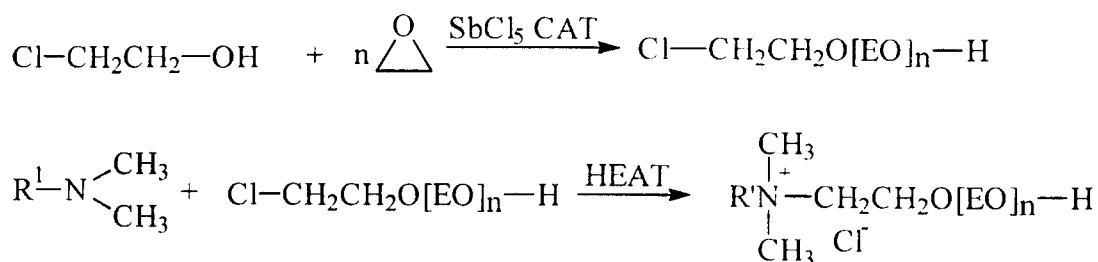
SCHEME 1



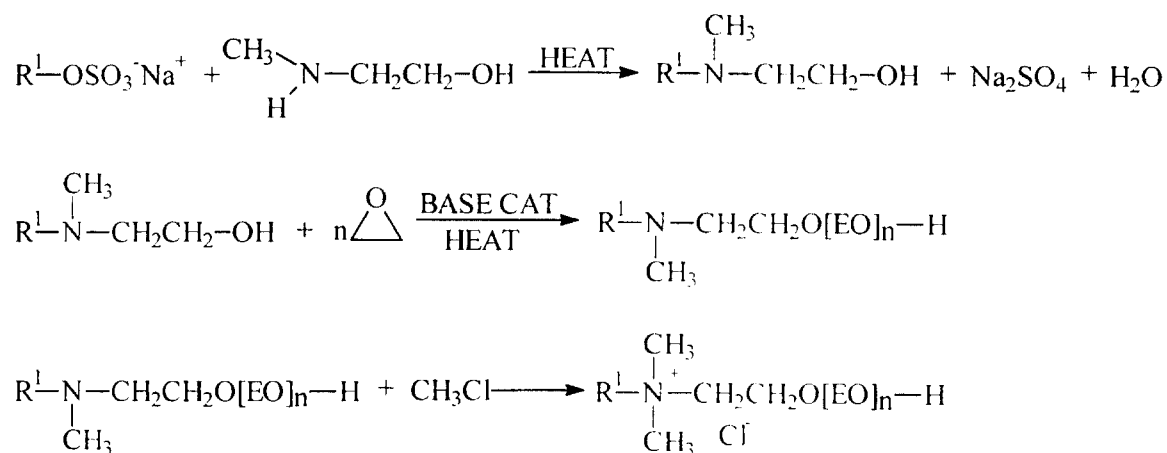
SCHEME 2



SCHEME 3

SCHEME 4

An economical reaction scheme is as follows.

SCHEME 5

For reaction Scheme 5, the following parameters summarize the optional and preferred reaction conditions herein for step 1. Step 1 of the reaction is preferably conducted in an aqueous medium. Reaction temperatures are typically in the range of 100-230°C. Reaction pressures are 50-1000 psig. A base, preferably sodium hydroxide, can be used to react with the HSO<sub>4</sub><sup>-</sup> generated during the reaction. In another mode, an excess of the amine can be employed to also react with the acid. The mole ratio of amine to alkyl sulfate is typically from 10:1 to 1:1.5; preferably from 5:1 to 1:1.1; more preferably from 2:1 to 1:1. In the product recovery step, the desired substituted amine is simply allowed to separate as a distinct phase from the aqueous reaction medium in which it is insoluble. The product of step 1 is then ethoxylated and quaternized using standard reactions, as shown.

The following illustrates the foregoing for the convenience of the formulator, but is not intended to be limiting thereof.

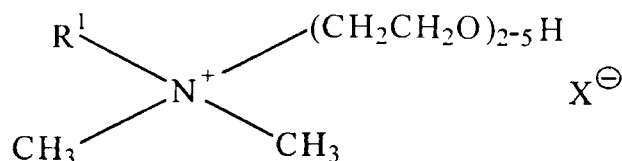
Preparation of N-(2-hydroxyethyl)-N-methyldodecylamine - To a glass autoclave liner is added 156.15 g of sodium dodecyl sulfate (0.5415 moles), 81.34 g of 2-(methylamino)ethanol (1.083 moles), 324.5 g of distilled H<sub>2</sub>O, and 44.3 g of 50 wt. % sodium hydroxide solution (0.5538 moles NaOH). The glass liner is sealed into 3 L, stainless steel, rocking autoclave, purged twice with 260 psig nitrogen and then heated to 160-180°C under 700-800 psig nitrogen for 3 hours. The mixture is cooled to room temperature and the liquid contents of the glass liner are poured into a 1 L separatory funnel. The mixture is separated into a clear lower layer, turbid middle layer and clear upper layer. The clear upper layer is isolated and placed under full vacuum (<100 mm Hg) at 60-65°C with mixing to remove any residual water. The clear liquid turns cloudy upon removing residual water as additional salts crystallizes out. The liquid is vacuum filtered to remove salts to again obtain a clear, colorless liquid. After a few days at room temperature, additional salts crystallize and settle out. The liquid is vacuum filtered to remove solids and again a clear, colorless liquid is obtained which remains stable. The isolated clear, colorless liquid is the title product by NMR analysis and is >90% by GC analysis with a typical recovery of >90%. The amine is then ethoxylated in standard fashion. Quaternization with an alkyl halide to form the AQA surfactants herein is routine.

According to the foregoing, the following are nonlimiting, specific illustrations of AQA surfactants used herein. It is to be understood that the degree of alkoxylation noted herein for the AQA surfactants is reported as an average, following common practice for conventional ethoxylated nonionic surfactants. This is because the ethoxylation reactions typically yield mixtures of materials with differing degrees of ethoxylation. Thus, it is not uncommon to report total EO values other than as whole numbers, e.g., "EO2.5", "EO3.5", and the like.

<u>Designation</u>	<u>R<sup>1</sup></u>	<u>R<sup>2</sup></u>	<u>R<sup>3</sup></u>	<u>Alkoxylation</u>
AQA-1	C <sub>12</sub> -C <sub>14</sub>	CH <sub>3</sub>	CH <sub>3</sub>	EO2
AQA-2	C <sub>10</sub> -C <sub>16</sub>	CH <sub>3</sub>	CH <sub>3</sub>	EO2
AQA-3	C <sub>12</sub>	CH <sub>3</sub>	CH <sub>3</sub>	EO2
AQA-4	C <sub>14</sub>	CH <sub>3</sub>	CH <sub>3</sub>	EO2-3

AQA-5	C <sub>10</sub> -C <sub>18</sub>	CH <sub>3</sub>	CH <sub>3</sub>	EO5-8
AQA-6	C <sub>12</sub> -C <sub>14</sub>	C <sub>2</sub> H <sub>5</sub>	CH <sub>3</sub>	EO3-5
AQA-7	C <sub>14</sub> -C <sub>16</sub>	CH <sub>3</sub>	C <sub>3</sub> H <sub>7</sub>	(EO/PrO)4
AQA-8	C <sub>12</sub> -C <sub>14</sub>	CH <sub>3</sub>	CH <sub>3</sub>	(PrO)3
AQA-9	C <sub>12</sub> -C <sub>18</sub>	CH <sub>3</sub>	CH <sub>3</sub>	EO10
AQA-10	C <sub>8</sub> -C <sub>18</sub>	CH <sub>3</sub>	CH <sub>3</sub>	EO15
AQA-11	C <sub>10</sub>	C <sub>2</sub> H <sub>5</sub>	C <sub>2</sub> H <sub>5</sub>	EO3.5
AQA-12	C <sub>10</sub>	CH <sub>3</sub>	CH <sub>3</sub>	EO2.5
AQA-13	C <sub>10</sub>	CH <sub>3</sub>	CH <sub>3</sub>	EO3.5
AQA-14	C <sub>10</sub>	C <sub>4</sub> H <sub>9</sub>	C <sub>4</sub> H <sub>9</sub>	EO30
AQA-15	C <sub>8</sub> C <sub>14</sub>	CH <sub>3</sub>	CH <sub>3</sub>	EO2
AQA-16	C <sub>10</sub>	CH <sub>3</sub>	CH <sub>3</sub>	EO10
AQA-17	C <sub>12</sub> -C <sub>18</sub>	C <sub>3</sub> H <sub>9</sub>	C <sub>3</sub> H <sub>7</sub>	Bu <sub>4</sub>
AQA-18	C <sub>12</sub> -C <sub>18</sub>	CH <sub>3</sub>	CH <sub>3</sub>	EO5
AQA-19	C <sub>8</sub>	CH <sub>3</sub>	CH <sub>3</sub>	iPr <sub>3</sub>
AQA-20	C <sub>8</sub>	CH <sub>3</sub>	CH <sub>3</sub>	EO3-7
AQA-21	C <sub>12</sub>	CH <sub>3</sub>	CH <sub>3</sub>	EO3.5
AQA-22	C <sub>12</sub>	CH <sub>3</sub>	CH <sub>3</sub>	EO4.5

Highly preferred AQA compound for use herein are of the formula



wherein  $\text{R}^1$  is C<sub>8</sub>-C<sub>18</sub> hydrocarbyl and mixtures thereof, especially C<sub>8</sub>-C<sub>14</sub> alkyl, preferably C<sub>8</sub>, C<sub>10</sub> and C<sub>12</sub> alkyl, and X is any convenient anion to provide charge balance, preferably chloride or bromide.

As noted, compounds of the foregoing type include those wherein the ethoxy (CH<sub>2</sub>CH<sub>2</sub>O) units (EO) are replaced by butoxy, isopropoxy [CH(CH<sub>3</sub>)CH<sub>2</sub>O] and [CH<sub>2</sub>CH(CH<sub>3</sub>)O] units (i-Pr) or n-propoxy units (Pr), or mixtures of EO and/or Pr and/or i-Pr units.

#### Non-AQA Detersive Surfactants

In addition to the AQA surfactant, the compositions of the present invention preferably further comprise a non-AQA surfactant. Non-AQA surfactants may include essentially any anionic, nonionic or additional cationic surfactant.

#### Anionic Surfactant

Nonlimiting examples of anionic surfactants useful herein typically at levels from 1% to 55%, by weight, include the conventional C<sub>11</sub>-C<sub>18</sub> alkyl benzene sulfonates ("LAS") and primary ("AS"), branched-chain and random C<sub>10</sub>-C<sub>20</sub> alkyl sulfates, the C<sub>10</sub>-C<sub>18</sub> secondary (2,3) alkyl sulfates of the formula CH<sub>3</sub>(CH<sub>2</sub>)<sub>x</sub>(CHOSO<sub>3</sub><sup>-</sup>M<sup>+</sup>)CH<sub>3</sub> and CH<sub>3</sub>(CH<sub>2</sub>)<sub>y</sub>(CHOSO<sub>3</sub><sup>-</sup>M<sup>+</sup>)CH<sub>2</sub>CH<sub>3</sub> where x and (y + 1) are integers of at least 7, preferably at least 9, and M is a water-solubilizing cation, especially sodium, unsaturated sulfates such as oleyl sulfate, the C<sub>12</sub>-C<sub>18</sub> alpha-sulfonated fatty acid esters, the C<sub>10</sub>-C<sub>18</sub> sulfated polyglycosides, the C<sub>10</sub>-C<sub>18</sub> alkyl alkoxy sulfates ("AE<sub>x</sub>S"; especially EO 1-7 ethoxy sulfates), and the C<sub>10</sub>-C<sub>18</sub> alkyl alkoxy carboxylates (especially the EO 1-5 ethoxycarboxylates). The C<sub>12</sub>-C<sub>18</sub> betaines and sulfobetaines ("sultaines"), C<sub>10</sub>-C<sub>18</sub> amine oxides, can also be included in the overall compositions. C<sub>10</sub>-C<sub>20</sub> conventional soaps may also be used. If high sudsing is

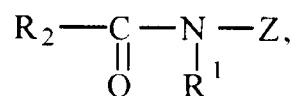
desired, the branched-chain C<sub>10</sub>-C<sub>16</sub> soaps may be used. Other conventional useful surfactants are listed in standard texts.

### Nonionic Surfactants

Nonlimiting examples of nonionic surfactants useful herein typically at levels from 1% to 55%, by weight include the alkoxyated alcohols (AE's) and alkyl phenols, polyhydroxy fatty acid amides (PFAA's), alkyl polyglycosides (APG's), C<sub>10</sub>-C<sub>18</sub> glycerol ethers.

More specifically, the condensation products of primary and secondary aliphatic alcohols with from 1 to 25 moles of ethylene oxide (AE) are suitable for use as the nonionic surfactant in the present invention. The alkyl chain of the aliphatic alcohol can either be straight or branched, primary or secondary, and generally contains from 8 to 22 carbon atoms. Preferred are the condensation products of alcohols having an alkyl group containing from 8 to 20 carbon atoms, more preferably from 10 to 18 carbon atoms, with from 1 to 10 moles, preferably 2 to 7, most preferably 2 to 5, of ethylene oxide per mole of alcohol. Examples of commercially available nonionic surfactants of this type include: Tergitol<sup>TM</sup> 15-S-9 (the condensation product of C<sub>11</sub>-C<sub>15</sub> linear alcohol with 9 moles ethylene oxide) and Tergitol<sup>TM</sup> 24-L-6 NMW (the condensation product of C<sub>12</sub>-C<sub>14</sub> primary alcohol with 6 moles ethylene oxide with a narrow molecular weight distribution), both marketed by Union Carbide Corporation; Neodol<sup>TM</sup> 45-9 (the condensation product of C<sub>14</sub>-C<sub>15</sub> linear alcohol with 9 moles of ethylene oxide), Neodol<sup>TM</sup> 23-3 (the condensation product of C<sub>12</sub>-C<sub>13</sub> linear alcohol with 3 moles of ethylene oxide), Neodol<sup>TM</sup> 45-7 (the condensation product of C<sub>14</sub>-C<sub>15</sub> linear alcohol with 7 moles of ethylene oxide) and Neodol<sup>TM</sup> 45-5 (the condensation product of C<sub>14</sub>-C<sub>15</sub> linear alcohol with 5 moles of ethylene oxide) marketed by Shell Chemical Company; Kyro<sup>TM</sup> EOB (the condensation product of C<sub>13</sub>-C<sub>15</sub> alcohol with 9 moles ethylene oxide), marketed by The Procter & Gamble Company; and Genapol LA O3O or O5O (the condensation product of C<sub>12</sub>-C<sub>14</sub> alcohol with 3 or 5 moles of ethylene oxide) marketed by Hoechst. The preferred range of HLB in these AE nonionic surfactants is from 8-11 and most preferred from 8-10. Condensates with propylene oxide and butylene oxides may also be used.

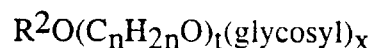
Another class of preferred nonionic surfactants for use herein are the polyhydroxy fatty acid amide surfactants of the formula.



wherein  $\text{R}^1$  is H, or  $\text{C}_{1-4}$  hydrocarbyl, 2-hydroxy ethyl, 2-hydroxy propyl or a mixture thereof,  $\text{R}^2$  is  $\text{C}_{5-31}$  hydrocarbyl, and Z is a polyhydroxyhydrocarbyl having a linear hydrocarbyl chain with at least 3 hydroxyls directly connected to the chain, or an alkoxyated derivative thereof. Preferably,  $\text{R}^1$  is methyl,  $\text{R}^2$  is a straight  $\text{C}_{11-15}$  alkyl or  $\text{C}_{15-17}$  alkyl or alkenyl chain such as coconut alkyl or mixtures thereof, and Z is derived from a reducing sugar such as glucose, fructose, maltose, lactose, in a reductive amination reaction. Typical examples include the  $\text{C}_{12-18}$  and  $\text{C}_{12-14}$  N-methylglucamides. See U.S. 5,194,639 and 5,298,636. N-alkoxy polyhydroxy fatty acid amides can also be used; see U.S. 5,489,393.

Also useful as the nonionic surfactant in the present invention are the alkylpolysaccharides such as those disclosed in U.S. Patent 4,565,647, Llenado, issued January 21, 1986, having a hydrophobic group containing from 6 to 30 carbon atoms, preferably from 10 to 16 carbon atoms, and a polysaccharide, e.g. a polyglycoside, hydrophilic group containing from 1.3 to 10, preferably from 1.3 to 3, most preferably from 1.3 to 2.7 saccharide 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 position of the additional saccharide units and the 2-, 3-, 4-, and/or 6- positions on the preceding saccharide units.

The preferred alkylpolyglycosides have the formula:



wherein  $\text{R}^2$  is selected from the group consisting of alkyl, alkylphenyl, hydroxyalkyl, hydroxyalkylphenyl, and mixtures thereof in which the alkyl groups contain from 10 to 18, preferably from 12 to 14, carbon atoms; n is 2 or 3, preferably 2; t is from 0 to 10, preferably 0; and x is from 1.3 to 10, preferably from 1.3 to 3, most preferably from 1.3 to 2.7. The glycosyl is preferably derived from glucose. To prepare these



compounds, the alcohol or alkylpolyethoxy 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.

Polyethylene, polypropylene, and polybutylene oxide condensates of alkyl phenols are also suitable for use as the nonionic surfactant of the surfactant systems of the present invention, with the polyethylene oxide condensates being preferred. These compounds include the condensation products of alkyl phenols having an alkyl group containing from 6 to 14 carbon atoms, preferably from 8 to 14 carbon atoms, in either a straight-chain or branched-chain configuration with the alkylene oxide. In a preferred embodiment, the ethylene oxide is present in an amount equal to from 2 to 25 moles, more preferably from 3 to 15 moles, of ethylene oxide per mole of alkyl phenol. Commercially available nonionic surfactants of this type include Igepal<sup>TM</sup> CO-630, marketed by the GAF Corporation; and Triton<sup>TM</sup> X-45, X-114, X-100 and X-102, all marketed by the Rohm & Haas Company. These surfactants are commonly referred to as alkylphenol alkoxyates (e.g., alkyl phenol ethoxyates).

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 as the additional nonionic surfactant in the present invention. The hydrophobic portion of these compounds will preferably have a molecular weight of from 1500 to 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 50% of the total weight of the condensation product, which corresponds to condensation with up to 40 moles of ethylene oxide. Examples of compounds of this type include certain of the commercially-available Pluronic<sup>TM</sup> surfactants, marketed by BASF.

Also suitable for use as the nonionic surfactant of the nonionic surfactant system of the present invention, are 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, and generally has a molecular weight of from 2500 to 3000. This

hydrophobic moiety is condensed with ethylene oxide to the extent that the condensation product contains from 40% to 80% by weight of polyoxyethylene and has a molecular weight of from 5,000 to 11,000. Examples of this type of nonionic surfactant include certain of the commercially available Tetronic<sup>TM</sup> compounds, marketed by BASF.

#### Additional Cationic surfactants

Suitable cationic surfactants are preferably water dispersible compound having surfactant properties comprising at least one ester (ie -COO-) linkage and at least one cationically charged group.

Other suitable cationic surfactants include the quaternary ammonium surfactants selected from mono C<sub>6</sub>-C<sub>16</sub>, preferably C<sub>6</sub>-C<sub>10</sub> N-alkyl or alkenyl ammonium surfactants wherein the remaining N positions are substituted by methyl, hydroxyethyl or hydroxypropyl groups. Other suitable cationic ester surfactants, including choline ester surfactants, have for example been disclosed in US Patents No.s 4228042, 4239660 and 4260529.

#### Optional Detergent Ingredients

The following illustrates various other optional ingredients which may be used in the compositions of this invention, but is not intended to be limiting thereof.

#### Additional Bleach Agent

The detergent compositions herein may comprise an additional bleaching agent. Such bleaching agents are typically present at levels of from 1% to 20%, more typically from 3% to 15%, of the detergent composition, especially for fabric laundering.

Other suitable bleaching agents include chlorine and photoactivated bleaching agents. Examples of photoactivated bleaching agents include the sulfonated zinc and/or aluminum phthalocyanines. See U.S. Patent 4,033,718, issued July 5, 1977 to Holcombe et al. If used, detergent compositions will typically contain from 0.025% to 1.25%, by weight, of such bleaches, especially sulfonate zinc phthalocyanine.

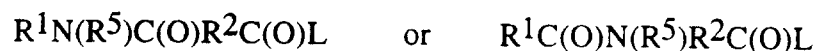
#### Bleach Activator

A preferred component of the composition of the present invention is a bleach activator. Bleach activators are typically present at levels of from 0.1% to 60%, more typically from 0.5% to 40% of the bleaching composition comprising the bleaching agent-plus-bleach activator.

Peroxygen bleaching agents, the perborates, etc., are preferably combined with bleach activators, which lead to the *in situ* production in aqueous solution (i.e., during the washing process) of the peroxy acid or peracid corresponding to the bleach activator. Various nonlimiting examples of activators are disclosed in U.S. Patent 4,915,854, issued April 10, 1990 to Mao et al, and U.S. Patent 4,412,934. The nonanoyloxybenzene sulfonate (NOBS) and tetraacetyl ethylene diamine (TAED) activators are typical, and mixtures thereof can also be used. See also U.S. 4,634,551 for other typical bleaches and activators useful herein.

In an alternative preferred aspect a preformed peracid is incorporated directly into the composition. Compositions containing mixtures of a hydrogen peroxide source and bleach activator in combination with a preformed peracid are also envisaged

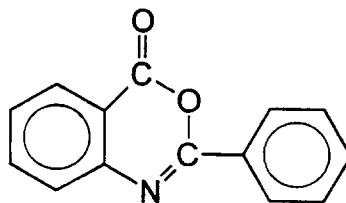
Highly preferred amido-derived bleach activators are those of the formulae:



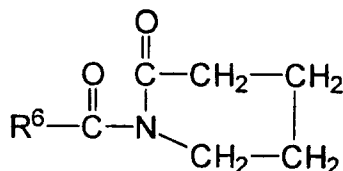
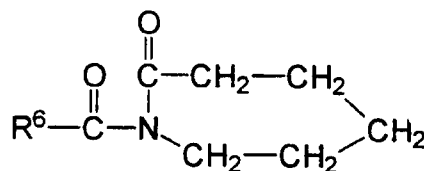
wherein  $R^1$  is an alkyl group containing from 6 to 12 carbon atoms,  $R^2$  is an alkylene containing from 1 to 6 carbon atoms,  $R^5$  is H or alkyl, aryl, or alkaryl containing from 1 to 10 carbon atoms, and L is any suitable leaving group. A leaving group is any group that is displaced from the bleach activator as a consequence of the nucleophilic attack on the bleach activator by the perhydrolysis anion. A preferred leaving group is phenyl sulfonate.

Preferred examples of bleach activators of the above formulae include (6-octanamido-caproyl)oxybenzenesulfonate, (6-nonanamidocaproyl)oxybenzenesulfonate, (6-decanamido-caproyl)oxybenzenesulfonate, and mixtures thereof as described in U.S. Patent 4,634,551, incorporated herein by reference.

Another class of bleach activators comprises the benzoxazin-type activators disclosed by Hodge et al in U.S. Patent 4,966,723, issued October 30, 1990, incorporated herein by reference. A highly preferred activator of the benzoxazin-type is:



Still another class of preferred bleach activators includes the acyl lactam activators, especially acyl caprolactams and acyl valerolactams of the formulae:



wherein  $R^6$  is H or an alkyl, aryl, alkoxyaryl, or alkaryl group containing from 1 to 12 carbon atoms. Highly preferred lactam activators include benzoyl caprolactam, octanoyl caprolactam, 3,5,5-trimethylhexanoyl caprolactam, nonanoyl caprolactam, decanoyl caprolactam, undecenoyl caprolactam, benzoyl valerolactam, octanoyl valerolactam, decanoyl valerolactam, undecenoyl valerolactam, nonanoyl valerolactam, 3,5,5-trimethylhexanoyl valerolactam and mixtures thereof. See also U.S. Patent 4,545,784, issued to Sanderson, October 8, 1985, incorporated herein by reference, which discloses acyl caprolactams, including benzoyl caprolactam, adsorbed into sodium perborate.

### Builders

Detergent builders can optionally but preferably be included in the compositions herein, for example to assist in controlling mineral, especially Ca and/or Mg, hardness in wash water or to assist in the removal of particulate soils from surfaces. Builders can operate via a variety of mechanisms including forming soluble or insoluble complexes with hardness ions, by ion exchange, and by offering a surface more favorable to the precipitation of hardness ions than are the surfaces of articles to be cleaned. Builder level can vary widely depending upon end use and physical form of the composition. Built detergents typically comprise at least 1% builder. Liquid formulations typically comprise 5% to 50%, more typically 5% to 35% of builder. Granular formulations typically comprise from 10% to 80%, more typically 15% to 50% builder by weight of the detergent composition. Lower or higher levels of builders are not excluded. For example, certain detergent additive or high-surfactant formulations can be unbuilt.

Suitable builders herein can be selected from the group consisting of phosphates and polyphosphates, especially the sodium salts; silicates including water-soluble and hydrous solid types and including those having chain-, layer-, or three-dimensional-structure as well as amorphous-solid or non-structured-liquid types; carbonates, bicarbonates, sesquicarbonates and carbonate minerals other than sodium carbonate or sesquicarbonate; aluminosilicates; organic mono-, di-, tri-, and tetracarboxylates especially water-soluble nonsurfactant carboxylates in acid, sodium, potassium or alkanolammonium salt form, as well as oligomeric or water-soluble low molecular weight polymer carboxylates including aliphatic and aromatic types; and phytic acid. These may be complemented by borates, e.g., for pH-buffering purposes, or by sulfates, especially sodium sulfate and any other fillers or carriers which may be important to the engineering of stable surfactant and/or builder-containing detergent compositions.

Builder mixtures, sometimes termed "builder systems" can be used and typically comprise two or more conventional builders, optionally complemented by chelants, pH-buffers or fillers, though these latter materials are generally accounted for separately when describing quantities of materials herein. In terms of relative quantities of surfactant and builder in the present detergents, preferred builder systems are typically formulated at a weight ratio of surfactant to builder of from 60:1 to 1:80. Certain preferred laundry detergents have said ratio in the range 0.90:1.0 to 4.0:1.0, more preferably from 0.95:1.0 to 3.0:1.0.

P-containing detergent builders often preferred where permitted by legislation include, but are not limited to, the alkali metal, ammonium and alkanolammonium salts of polyphosphates exemplified by the tripolyphosphates, pyrophosphates, glassy polymeric meta-phosphates; and phosphonates.

Suitable silicate builders include alkali metal silicates, particularly those liquids and solids having a  $\text{SiO}_2:\text{Na}_2\text{O}$  ratio in the range 1.6:1 to 3.2:1, including, particularly for automatic dishwashing purposes, solid hydrous 2-ratio silicates marketed by PQ Corp. under the tradename BRITESIL<sup>®</sup>, e.g., BRITESIL H2O; and layered silicates, e.g., those described in U.S. 4,664,839, May 12, 1987, H. P. Rieck. NaSKS-6, sometimes abbreviated "SKS-6", is a crystalline layered aluminium-free  $\delta\text{-Na}_2\text{SiO}_5$  morphology silicate marketed by Hoechst and is preferred especially in granular laundry compositions. See preparative methods in German DE-A-3,417,649 and DE-A-3,742,043. Other layered silicates, such as those having the general formula  $\text{NaMSi}_x\text{O}_{2x+1}\cdot y\text{H}_2\text{O}$  wherein M is sodium or hydrogen, x is a number from 1.9 to 4, preferably 2, and y is a number from 0 to 20, preferably 0, can also or alternately be used herein. Layered silicates from Hoechst also include NaSKS-5, NaSKS-7 and NaSKS-11, as the  $\alpha$ ,  $\beta$  and  $\gamma$  layer-silicate forms. Other silicates may also be useful, such as magnesium silicate, which can serve as a crispening agent in granules, as a stabilising agent for bleaches, and as a component of suds control systems.

Also suitable for use herein are synthesized crystalline ion exchange materials or hydrates thereof having chain structure and a composition represented by the following general formula in an anhydride form:  $x\text{M}_2\text{O}\cdot y\text{SiO}_2\cdot z\text{M}'\text{O}$  wherein M is Na and/or K, M' is Ca and/or Mg;  $y/x$  is 0.5 to 2.0 and  $z/x$  is 0.005 to 1.0 as taught in U.S. 5,427,711, Sakaguchi et al, June 27, 1995.

Suitable carbonate builders include alkaline earth and alkali metal carbonates as disclosed in German Patent Application No. 2,321,001 published on November 15, 1973, although sodium bicarbonate, sodium carbonate, sodium sesquicarbonate, and other carbonate minerals such as trona or any convenient multiple salts of sodium carbonate and calcium carbonate such as those having the composition  $2\text{Na}_2\text{CO}_3\cdot\text{CaCO}_3$  when anhydrous, and even calcium carbonates including calcite, aragonite and vaterite, especially forms having high surface areas relative to compact calcite may be useful, for example as seeds or for use in synthetic detergent bars.

Aluminosilicate builders are especially useful in granular detergents, but can also be incorporated in liquids, pastes or gels. Suitable for the present purposes are those having empirical formula:  $[M_z(\text{AlO}_2)_z(\text{SiO}_2)_v] \cdot x\text{H}_2\text{O}$  wherein  $z$  and  $v$  are integers of at least 6, the molar ratio of  $z$  to  $v$  is in the range from 1.0 to 0.5, and  $x$  is an integer from 15 to 264. Aluminosilicates can be crystalline or amorphous, naturally-occurring or synthetically derived. An aluminosilicate production method is in U.S. 3,985,669, Krummel, et al, October 12, 1976. Preferred synthetic crystalline aluminosilicate ion exchange materials are available as Zeolite A, Zeolite P (B), Zeolite X and, to whatever extent this differs from Zeolite P, the so-called Zeolite MAP. Natural types, including clinoptilolite, may be used. Zeolite A has the formula:

$\text{Na}_{12}[(\text{AlO}_2)_{12}(\text{SiO}_2)_{12}] \cdot x\text{H}_2\text{O}$  wherein  $x$  is from 20 to 30, especially 27. Dehydrated zeolites ( $x = 0 - 10$ ) may also be used. Preferably, the aluminosilicate has a particle size of 0.1-10 microns in diameter.

Suitable organic detergent builders include polycarboxylate compounds, including water-soluble nonsurfactant dicarboxylates and tricarboxylates. More typically builder polycarboxylates have a plurality of carboxylate groups, preferably at least 3 carboxylates. Carboxylate builders can be formulated in acid, partially neutral, neutral or overbased form. When in salt form, alkali metals, such as sodium, potassium, and lithium, or alkanolammonium salts are preferred. Polycarboxylate builders include the ether polycarboxylates, such as oxydisuccinate, see Berg, U.S. 3,128,287, April 7, 1964, and Lamberti et al, U.S. 3,635,830, January 18, 1972; "TMS/TDS" builders of U.S. 4,663,071, Bush et al, May 5, 1987; and other ether carboxylates including cyclic and alicyclic compounds, such as those described in U.S. Patents 3,923,679; 3,835,163; 4,158,635; 4,120,874 and 4,102,903.

Other suitable builders are the ether hydroxypolycarboxylates, copolymers of maleic anhydride with ethylene or vinyl methyl ether; 1, 3, 5-trihydroxy benzene-2, 4, 6-trisulphonic acid; carboxymethyloxysuccinic acid; the various alkali metal, ammonium and substituted ammonium salts of polyacetic acids such as ethylenediamine tetraacetic acid and nitrilotriacetic acid; as well as mellitic acid, succinic acid, polymaleic acid, benzene 1,3,5-tricarboxylic acid, carboxymethyloxysuccinic acid, and soluble salts thereof.

Citrates, e.g., citric acid and soluble salts thereof are important carboxylate builders e.g., for heavy duty liquid detergents, due to availability from renewable resources and

biodegradability. Citrates can also be used in granular compositions, especially in combination with zeolite and/or layered silicates. Oxydisuccinates are also especially useful in such compositions and combinations.

Where permitted, and especially in the formulation of bars used for hand-laundering operations, alkali metal phosphates such as sodium tripolyphosphates, sodium pyrophosphate and sodium orthophosphate can be used. Phosphonate builders such as ethane-1-hydroxy-1,1-diphosphonate and other known phosphonates, e.g., those of U.S. 3,159,581; 3,213,030; 3,422,021; 3,400,148 and 3,422,137 can also be used and may have desirable antiscaling properties.

Certain deterative surfactants or their short-chain homologs also have a builder action. For unambiguous formula accounting purposes, when they have surfactant capability, these materials are summed up as deterative surfactants. Preferred types for builder functionality are illustrated by: 3,3-dicarboxy-4-oxa-1,6-hexanedioates and the related compounds disclosed in U.S. 4,566,984, Bush, January 28, 1986. Succinic acid builders include the C<sub>5</sub>-C<sub>20</sub> alkyl and alkenyl succinic acids and salts thereof. Succinate builders also include: laurylsuccinate, myristylsuccinate, palmitylsuccinate, 2-dodecenylsuccinate (preferred), 2-pentadecenylsuccinate. Lauryl-succinates are described in European Patent Application 86200690.5/0,200,263, published November 5, 1986. Fatty acids, e.g., C<sub>12</sub>-C<sub>18</sub> monocarboxylic acids, can also be incorporated into the compositions as surfactant/builder materials alone or in combination with the aforementioned builders, especially citrate and/or the succinate builders, to provide additional builder activity. Other suitable polycarboxylates are disclosed in U.S. 4,144,226, Crutchfield et al, March 13, 1979 and in U.S. 3,308,067, Diehl, March 7, 1967. See also Diehl, U.S. 3,723,322.

Other types of inorganic builder materials which can be used have the formula  $(M_x)_i Ca_y (CO_3)_z$  wherein x and i are integers from 1 to 15, y is an integer from 1 to 10, z is an integer from 2 to 25, M<sub>i</sub> are cations, at least one of which is a water-soluble, and the equation  $\sum_i = 1-15(x_i \text{ multiplied by the valence of } M_i) + 2y = 2z$  is satisfied such that the formula has a neutral or "balanced" charge. These builders are referred to herein as "Mineral Builders". Waters of hydration or anions other than carbonate may be added provided that the overall charge is balanced or neutral. The charge or valence effects of such anions should be added to the right side of the above equation. Preferably, there is present a water-soluble cation selected from the group consisting of



hydrogen, water-soluble metals, hydrogen, boron, ammonium, silicon, and mixtures thereof, more preferably, sodium, potassium, hydrogen, lithium, ammonium and mixtures thereof, sodium and potassium being highly preferred. Nonlimiting examples of noncarbonate anions include those selected from the group consisting of chloride, sulfate, fluoride, oxygen, hydroxide, silicon dioxide, chromate, nitrate, borate and mixtures thereof. Preferred builders of this type in their simplest forms are selected from the group consisting of  $\text{Na}_2\text{Ca}(\text{CO}_3)_2$ ,  $\text{K}_2\text{Ca}(\text{CO}_3)_2$ ,  $\text{Na}_2\text{Ca}_2(\text{CO}_3)_3$ ,  $\text{NaKCa}(\text{CO}_3)_2$ ,  $\text{NaKCa}_2(\text{CO}_3)_3$ ,  $\text{K}_2\text{Ca}_2(\text{CO}_3)_3$ , and combinations thereof. An especially preferred material for the builder described herein is  $\text{Na}_2\text{Ca}(\text{CO}_3)_2$  in any of its crystalline modifications. Suitable builders of the above-defined type are further illustrated by, and include, the natural or synthetic forms of any one or combinations of the following minerals: Afghanite, Andersonite, AshcroftineY, Beyerite, Borcarite, Burbankite, Butschliite, Cancrinite, Carbocernaite, Carletonite, Davyne, DonnayiteY, Fairchildite, Ferrisurite, Franzinite, Gaudefroyite, Gaylussite, Girvasite, Gregoryite, Jouravskite, KamphaugiteY, Kettnerite, Khanneshite, LepersonniteGd, Liottite, MckelveyiteY, Microsommite, Mroseite, Natrofairchildite, Nyerereite, RemonditeCe, Sacrofanite, Schrockingerite, Shortite, Surite, Tunisite, Tuscanite, Tyrolite, Vishnevite, and Zemkorite. Preferred mineral forms include Nyerereite, Fairchildite and Shortite.

### Enzymes

Enzymes can be included in the present detergent compositions for a variety of purposes, including removal of protein-based, carbohydrate-based, or triglyceride-based stains from substrates, for the prevention of refugee dye transfer in fabric laundering, and for fabric restoration. Suitable enzymes include proteases, amylases, lipases, cellulases, peroxidases, and mixtures thereof of any suitable origin, such as vegetable, animal, bacterial, fungal and yeast origin. Preferred selections are influenced by factors such as pH-activity and/or stability optima, thermostability, and stability to active detergents, builders. In this respect bacterial or fungal enzymes are preferred, such as bacterial amylases and proteases, and fungal cellulases.

"Detersive enzyme", as used herein, means any enzyme having a cleaning, stain removing or otherwise beneficial effect in a laundry, hard surface cleaning or personal care detergent composition. Preferred detersive enzymes are hydrolases such as proteases, amylases and lipases. Preferred enzymes for laundry purposes include, but

are not limited to, proteases, cellulases, lipases and peroxidases. Highly preferred for automatic dishwashing are amylases and/or proteases.

Enzymes are normally incorporated into detergent or detergent additive compositions at levels sufficient to provide a "cleaning-effective amount". The term "cleaning effective amount" refers to any amount capable of producing a cleaning, stain removal, soil removal, whitening, deodorizing, or freshness improving effect on substrates such as fabrics, dishware. In practical terms for current commercial preparations, typical amounts are up to 5 mg by weight, more typically 0.01 mg to 3 mg, of active enzyme per gram of the detergent composition. Stated otherwise, the compositions herein will typically comprise from 0.001% to 5%, preferably 0.01%-1% by weight of a commercial enzyme preparation. Protease enzymes are usually present in such commercial preparations at levels sufficient to provide from 0.005 to 0.1 Anson units (AU) of activity per gram of composition. For certain detergents, such as in automatic dishwashing, it may be desirable to increase the active enzyme content of the commercial preparation in order to minimize the total amount of non-catalytically active materials and thereby improve spotting/filming or other end-results. Higher active levels may also be desirable in highly concentrated detergent formulations.

Suitable examples of proteases are the subtilisins which are obtained from particular strains of *B. subtilis* and *B. licheniformis*. One suitable protease is obtained from a strain of *Bacillus*, having maximum activity throughout the pH range of 8-12, developed and sold as ESPERASE® by Novo Industries A/S of Denmark, hereinafter "Novo". The preparation of this enzyme and analogous enzymes is described in GB 1,243,784 to Novo. Other suitable proteases include ALCALASE® and SAVINASE® from Novo and MAXATASE® from International Bio-Synthetics, Inc., The Netherlands; as well as Protease A as disclosed in EP 130,756 A, January 9, 1985 and Protease B as disclosed in EP 303,761 A, April 28, 1987 and EP 130,756 A, January 9, 1985. See also a high pH protease from *Bacillus* sp. NCIMB 40338 described in WO 9318140 A to Novo. Enzymatic detergents comprising protease, one or more other enzymes, and a reversible protease inhibitor are described in WO 9203529 A to Novo. Other preferred proteases include those of WO 9510591 A to Procter & Gamble. When desired, a protease having decreased adsorption and increased hydrolysis is available as described in WO 9507791 to Procter & Gamble. A recombinant trypsin-like protease for detergents suitable herein is described in WO 9425583 to Novo.

In more detail, an especially preferred protease, referred to as "Protease D" is a carbonyl hydrolase variant having an amino acid sequence not found in nature, which is derived from a precursor carbonyl hydrolase by substituting a different amino acid for a plurality of amino acid residues at a position in said carbonyl hydrolase equivalent to position +76, preferably also in combination with one or more amino acid residue positions equivalent to those selected from the group consisting of +99, +101, +103, +104, +107, +123, +27, +105, +109, +126, +128, +135, +156, +166, +195, +197, +204, +206, +210, +216, +217, +218, +222, +260, +265, and/or +274 according to the numbering of *Bacillus amyloliquefaciens* subtilisin, as described in the patent applications of A. Baeck, et al, entitled "Protease-Containing Cleaning Compositions" having US Serial No. 08/322,676, and C. Ghosh, et al, "Bleaching Compositions Comprising Protease Enzymes" having US Serial No. 08/322,677, both filed October 13, 1994.

Amylases suitable herein, especially for, but not limited to automatic dishwashing purposes, include, for example,  $\alpha$ -amylases described in GB 1,296,839 to Novo; RAPIDASE<sup>®</sup>, International Bio-Synthetics, Inc. and TERMAMYL<sup>®</sup>, Novo. FUNGAMYL<sup>®</sup> from Novo is especially useful. Engineering of enzymes for improved stability, e.g., oxidative stability, is known. See, for example J. Biological Chem., Vol. 260, No. 11, June 1985, pp. 6518-6521. Certain preferred embodiments of the present compositions can make use of amylases having improved stability in detergents such as automatic dishwashing types, especially improved oxidative stability as measured against a reference-point of TERMAMYL<sup>®</sup> in commercial use in 1993. These preferred amylases herein share the characteristic of being "stability-enhanced" amylases, characterized, at a minimum, by a measurable improvement in one or more of: oxidative stability, e.g., to hydrogen peroxide/tetraacetylenediamine in buffered solution at pH 9-10; thermal stability, e.g., at common wash temperatures such as 60°C; or alkaline stability, e.g., at a pH from 8 to 11, measured versus the above-identified reference-point amylase. Stability can be measured using any of the art-disclosed technical tests. See, for example, references disclosed in WO 9402597. Stability-enhanced amylases can be obtained from Novo or from Genencor International. One class of highly preferred amylases herein have the commonality of being derived using site-directed mutagenesis from one or more of the *Bacillus* amylases, especially the *Bacillus*  $\alpha$ -amylases, regardless of whether one, two or multiple amylase strains are the immediate precursors. Oxidative stability-enhanced amylases vs. the above-identified reference amylase are preferred for use, especially in

bleaching, more preferably oxygen bleaching, as distinct from chlorine bleaching, detergent compositions herein. Such preferred amylases include (a) an amylase according to the hereinbefore incorporated WO 9402597, Novo, Feb. 3, 1994, as further illustrated by a mutant in which substitution is made, using alanine or threonine, preferably threonine, of the methionine residue located in position 197 of the *B. licheniformis* alpha-amylase, known as TERMAMYL<sup>®</sup>, or the homologous position variation of a similar parent amylase, such as *B. amyloliquefaciens*, *B. subtilis*, or *B. stearothermophilus*; (b) stability-enhanced amylases as described by Genencor International in a paper entitled "Oxidatively Resistant alpha-Amylases" presented at the 207th American Chemical Society National Meeting, March 13-17 1994, by C. Mitchinson. Therein it was noted that bleaches in automatic dishwashing detergents inactivate alpha-amylases but that improved oxidative stability amylases have been made by Genencor from *B. licheniformis* NCIB8061. Methionine (Met) was identified as the most likely residue to be modified. Met was substituted, one at a time, in positions 8, 15, 197, 256, 304, 366 and 438 leading to specific mutants, particularly important being M197L and M197T with the M197T variant being the most stable expressed variant. Stability was measured in CASCADE<sup>®</sup> and SUNLIGHT<sup>®</sup>; (c) particularly preferred amylases herein include amylase variants having additional modification in the immediate parent as described in WO 9510603 A and are available from the assignee, Novo, as DURAMYL<sup>®</sup>. Other particularly preferred oxidative stability enhanced amylase include those described in WO 9418314 to Genencor International and WO 9402597 to Novo. Any other oxidative stability-enhanced amylase can be used, for example as derived by site-directed mutagenesis from known chimeric, hybrid or simple mutant parent forms of available amylases. Other preferred enzyme modifications are accessible. See WO 9509909 A to Novo.

Other amylase enzymes include those described in WO 95/26397 and in co-pending application by Novo Nordisk PCT/DK96/00056. Specific amylase enzymes for use in the detergent compositions of the present invention include  $\alpha$ -amylases characterized by having a specific activity at least 25% higher than the specific activity of Termamyl<sup>®</sup> at a temperature range of 25°C to 55°C and at a pH value in the range of 8 to 10, measured by the Phadebas<sup>®</sup>  $\alpha$ -amylase activity assay. (Such Phadebas<sup>®</sup>  $\alpha$ -amylase activity assay is described at pages 9-10, WO 95/26397.) Also included herein are  $\alpha$ -amylases which are at least 80% homologous with the amino acid sequences shown in the SEQ ID listings in the references. These enzymes are preferably incorporated into laundry detergent compositions at a level from 0.00018% to 0.060% pure enzyme by

weight of the total composition, more preferably from 0.00024% to 0.048% pure enzyme by weight of the total composition.

Cellulases usable herein include both bacterial and fungal types, preferably having a pH optimum between 5 and 9.5. U.S. 4,435,307, Barbesgoard et al, March 6, 1984, discloses suitable fungal cellulases from *Humicola insolens* or *Humicola* strain DSM1800 or a cellulase 212-producing fungus belonging to the genus *Aeromonas*, and cellulase extracted from the hepatopancreas of a marine mollusk, *Dolabella Auricula Solander*. Suitable cellulases are also disclosed in GB-A-2.075.028; GB-A-2.095.275 and DE-OS-2.247.832. CAREZYME® and CELLUZYME® (Novo) are especially useful. See also WO 9117243 to Novo.

Suitable lipase enzymes for detergent usage include those produced by microorganisms of the *Pseudomonas* group, such as *Pseudomonas stutzeri* ATCC 19.154, as disclosed in GB 1,372,034. See also lipases in Japanese Patent Application 53,20487, laid open Feb. 24, 1978. This lipase is available from Amano Pharmaceutical Co. Ltd., Nagoya, Japan, under the trade name Lipase P "Amano," or "Amano-P." Other suitable commercial lipases include Amano-CES, lipases ex *Chromobacter viscosum*, e.g. *Chromobacter viscosum* var. *lipolyticum* NRRLB 3673 from Toyo Jozo Co., Tagata, Japan; *Chromobacter viscosum* lipases from U.S. Biochemical Corp., U.S.A. and Disoynt Co., The Netherlands, and lipases ex *Pseudomonas gladioli*. LIPOLASE® enzyme derived from *Humicola lanuginosa* and commercially available from Novo, see also EP 341,947, is a preferred lipase for use herein. Lipase and amylase variants stabilized against peroxidase enzymes are described in WO 9414951 A to Novo. See also WO 9205249 and RD 94359044.

In spite of the large number of publications on lipase enzymes, only the lipase derived from *Humicola lanuginosa* and produced in *Aspergillus oryzae* as host has so far found widespread application as additive for fabric washing products. It is available from Novo Nordisk under the tradename Lipolase™, as noted above. In order to optimize the stain removal performance of Lipolase, Novo Nordisk have made a number of variants. As described in WO 92/05249, the D96L variant of the native *Humicola lanuginosa* lipase improves the lard stain removal efficiency by a factor 4.4 over the wild-type lipase (enzymes compared in an amount ranging from 0.075 to 2.5 mg protein per liter). Research Disclosure No. 35944 published on March 10, 1994, by Novo Nordisk discloses that the lipase variant (D96L) may be added in an amount corresponding to

0.001-100- mg (5-500,000 LU/liter) lipase variant per liter of wash liquor. The present invention provides the benefit of improved whiteness maintenance on fabrics using low levels of D96L variant in detergent compositions containing the AQA surfactants in the manner disclosed herein, especially when the D96L is used at levels in the range of 50 LU to 8500 LU per liter of wash solution.

Cutinase enzymes suitable for use herein are described in WO 8809367 A to Genencor.

Peroxidase enzymes may be used in combination with oxygen sources, e.g., percarbonate, perborate, hydrogen peroxide, etc., for "solution bleaching" or prevention of transfer of dyes or pigments removed from substrates during the wash to other substrates present in the wash solution. Known peroxidases include horseradish peroxidase, ligninase, and haloperoxidases such as chloro- or bromo-peroxidase. Peroxidase-containing detergent compositions are disclosed in WO 89099813 A, October 19, 1989 to Novo and WO 8909813 A to Novo.

A range of enzyme materials and means for their incorporation into synthetic detergent compositions is also disclosed in WO 9307263 A and WO 9307260 A to Genencor International, WO 8908694 A to Novo, and U.S. 3,553,139, January 5, 1971 to McCarty et al. Enzymes are further disclosed in U.S. 4,101,457, Place et al, July 18, 1978, and in U.S. 4,507,219, Hughes, March 26, 1985. Enzyme materials useful for liquid detergent formulations, and their incorporation into such formulations, are disclosed in U.S. 4,261,868, Hora et al, April 14, 1981. Enzymes for use in detergents can be stabilised by various techniques. Enzyme stabilisation techniques are disclosed and exemplified in U.S. 3,600,319, August 17, 1971, Gedge et al, EP 199,405 and EP 200,586, October 29, 1986, Venegas. Enzyme stabilisation systems are also described, for example, in U.S. 3,519,570. A useful *Bacillus*, sp. AC13 giving proteases, xylanases and cellulases, is described in WO 9401532 A to Novo.

#### Enzyme Stabilizing System

The enzyme-containing compositions herein may optionally also comprise from 0.001% to 10%, preferably from 0.005% to 8%, most preferably from 0.01% to 6%, by weight of an enzyme stabilizing system. The enzyme stabilizing system can be any stabilizing system which is compatible with the detergents. Such a system may be inherently provided by other formulation actives, or be added separately, e.g., by the

formulator or by a manufacturer of detergent-ready enzymes. Such stabilizing systems can, for example, comprise calcium ion, boric acid, propylene glycol, short chain carboxylic acids, boronic acids, and mixtures thereof, and are designed to address different stabilization problems depending on the type and physical form of the detergent composition.

One stabilizing approach is the use of water-soluble sources of calcium and/or magnesium ions in the finished compositions which provide such ions to the enzymes. Calcium ions are generally more effective than magnesium ions and are preferred herein if only one type of cation is being used. Typical detergent compositions, especially liquids, will comprise from about 1 to about 30, preferably from about 2 to about 20, more preferably from about 8 to about 12 millimoles of calcium ion per liter of finished detergent composition, though variation is possible depending on factors including the multiplicity, type and levels of enzymes incorporated. Preferably water-soluble calcium or magnesium salts are employed, including for example calcium chloride, calcium hydroxide, calcium formate, calcium malate, calcium maleate, calcium hydroxide and calcium acetate; more generally, calcium sulfate or magnesium salts corresponding to the exemplified calcium salts may be used. Further increased levels of Calcium and/or Magnesium may of course be useful, for example for promoting the grease-cutting action of certain types of surfactant.

Another stabilizing approach is by use of borate species. See Severson, U.S. 4,537,706. Borate stabilizers, when used, may be at levels of up to 10% or more of the composition though more typically, levels of up to about 3% by weight of boric acid or other borate compounds such as borax or orthoborate are suitable for liquid detergent use. Substituted boric acids such as phenylboronic acid, butaneboronic acid, p-bromophenylboronic acid or the like can be used in place of boric acid and reduced levels of total boron in detergent compositions may be possible though the use of such substituted boron derivatives.

Stabilizing systems of certain cleaning compositions, for example automatic dishwashing compositions, may further comprise from 0 to 10%, preferably from 0.01% to 6% by weight, of chlorine bleach scavengers, added to prevent chlorine bleach species present in many water supplies from attacking and inactivating the enzymes, especially under alkaline conditions. While chlorine levels in water may be small, typically in the range from 0.5 ppm to 1.75 ppm, the available chlorine in the

total volume of water that comes in contact with the enzyme, for example during dish- or fabric-washing, can be relatively large; accordingly, enzyme stability to chlorine in-use is sometimes problematic. Since percarbonate has the ability to react with chlorine bleach the use of additional stabilizers against chlorine, may, most generally, not be essential, though improved results may be obtainable from their use. Suitable chlorine scavenger anions are widely known and readily available, and, if used, can be salts containing ammonium cations with sulfite, bisulfite, thiosulfite, thiosulfate, iodide, etc. Antioxidants such as carbamate, ascorbate, etc., organic amines such as ethylenediaminetetracetic acid (EDTA) or alkali metal salt thereof, monoethanolamine (MEA), and mixtures thereof can likewise be used. Likewise, special enzyme inhibition systems can be incorporated such that different enzymes have maximum compatibility. Other conventional scavengers such as bisulfate, nitrate, chloride, sources of hydrogen peroxide such as sodium perborate tetrahydrate, sodium perborate monohydrate and sodium percarbonate, as well as phosphate, condensed phosphate, acetate, benzoate, citrate, formate, lactate, malate, tartrate, salicylate, etc., and mixtures thereof can be used if desired. In general, since the chlorine scavenger function can be performed by ingredients separately listed under better recognized functions, (e.g., hydrogen peroxide sources), there is no absolute requirement to add a separate chlorine scavenger unless a compound performing that function to the desired extent is absent from an enzyme-containing embodiment of the invention; even then, the scavenger is added only for optimum results. Moreover, the formulator will exercise a chemist's normal skill in avoiding the use of any enzyme scavenger or stabilizer which is majorly incompatible, as formulated, with other reactive ingredients. In relation to the use of ammonium salts, such salts can be simply admixed with the detergent composition but are prone to adsorb water and/or liberate ammonia during storage. Accordingly, such materials, if present, are desirably protected in a particle such as that described in US 4,652,392, Baginski et al.

#### Polymeric Soil Release Agent

Known polymeric soil release agents, hereinafter "SRA" or "SRA's", can optionally be employed in the present detergent compositions. If utilized, SRA's will generally comprise from 0.01% to 10.0%, typically from 0.1% to 5%, preferably from 0.2% to 3.0% by weight, of the composition.



Preferred SRA's typically have hydrophilic segments to hydrophilize the surface of hydrophobic fibers such as polyester and nylon, and hydrophobic segments to deposit upon hydrophobic fibers and remain adhered thereto through completion of washing and rinsing cycles thereby serving as an anchor for the hydrophilic segments. This can enable stains occurring subsequent to treatment with SRA to be more easily cleaned in later washing procedures.

SRA's can include a variety of charged, e.g., anionic or even cationic (see U.S. 4,956,447), as well as noncharged monomer units and structures may be linear, branched or even star-shaped. They may include capping moieties which are especially effective in controlling molecular weight or altering the physical or surface-active properties. Structures and charge distributions may be tailored for application to different fiber or textile types and for varied detergent or detergent additive products.

Preferred SRA's include oligomeric terephthalate esters, typically prepared by processes involving at least one transesterification/oligomerization, often with a metal catalyst such as a titanium(IV) alkoxide. Such esters may be made using additional monomers capable of being incorporated into the ester structure through one, two, three, four or more positions, without of course forming a densely crosslinked overall structure.

Suitable SRA's include: a sulfonated product of a substantially linear ester oligomer comprised of an oligomeric ester backbone of terephthaloyl and oxyalkyleneoxy repeat units and allyl-derived sulfonated terminal moieties covalently attached to the backbone, for example as described in U.S. 4,968,451, November 6, 1990 to J.J. Scheibel and E.P. Gosselink: such ester oligomers can be prepared by (a) ethoxylating allyl alcohol, (b) reacting the product of (a) with dimethyl terephthalate ("DMT") and 1,2-propylene glycol ("PG") in a two-stage transesterification/ oligomerization procedure and (c) reacting the product of (b) with sodium metabisulfite in water; the nonionic end-capped 1,2-propylene/polyoxyethylene terephthalate polyesters of U.S. 4,711,730, December 8, 1987 to Gosselink et al, for example those produced by transesterification/oligomerization of poly(ethyleneglycol) methyl ether, DMT, PG and poly(ethyleneglycol) ("PEG"); the partly- and fully- anionic-end-capped oligomeric esters of U.S. 4,721,580, January 26, 1988 to Gosselink, such as oligomers from ethylene glycol ("EG"), PG, DMT and Na-3,6-dioxa-8-hydroxyoctanesulfonate; the nonionic-capped block polyester oligomeric compounds of U.S. 4,702,857, October

27, 1987 to Gosselink, for example produced from DMT, Me-capped PEG and EG and/or PG, or a combination of DMT, EG and/or PG, Me-capped PEG and Na-dimethyl-5-sulfoisophthalate; and the anionic, especially sulfoaroyl, end-capped terephthalate esters of U.S. 4,877,896, October 31, 1989 to Maldonado, Gosselink et al, the latter being typical of SRA's useful in both laundry and fabric conditioning products, an example being an ester composition made from m-sulfobenzoic acid monosodium salt, PG and DMT optionally but preferably further comprising added PEG, e.g., PEG 3400.

SRA's also include simple copolymeric blocks of ethylene terephthalate or propylene terephthalate with polyethylene oxide or polypropylene oxide terephthalate, see U.S. 3,959,230 to Hays, May 25, 1976 and U.S. 3,893,929 to Basadur, July 8, 1975; cellulosic derivatives such as the hydroxyether cellulosic polymers available as METHOCEL from Dow; and the C<sub>1</sub>-C<sub>4</sub> alkylcelluloses and C<sub>4</sub> hydroxyalkyl celluloses; see U.S. 4,000,093, December 28, 1976 to Nicol, et al. Suitable SRA's characterised by poly(vinyl ester) hydrophobe segments include graft copolymers of poly(vinyl ester), e.g., C<sub>1</sub>-C<sub>6</sub> vinyl esters, preferably poly(vinyl acetate), grafted onto polyalkylene oxide backbones. See European Patent Application 0 219 048, published April 22, 1987 by Kud, et al. Commercially available examples include SOKALAN SRA's such as SOKALAN HP-22, available from BASF, Germany. Other SRA's are polyesters with repeat units containing 10-15% by weight of ethylene terephthalate together with 90-80% by weight of polyoxyethylene terephthalate, derived from a polyoxyethylene glycol of average molecular weight 300-5,000. Commercial examples include ZELCON 5126 from Dupont and MILEASE T from ICI.

Another preferred SRA is an oligomer having empirical formula (CAP)<sub>2</sub>(EG/PG)<sub>5</sub>(T)<sub>5</sub>(SIP)<sub>1</sub> which comprises terephthaloyl (T), sulfoisophthaloyl (SIP), oxyethyleneoxy and oxy-1,2-propylene (EG/PG) units and which is preferably terminated with end-caps (CAP), preferably modified isethionates, as in an oligomer comprising one sulfoisophthaloyl unit, 5 terephthaloyl units, oxyethyleneoxy and oxy-1,2-propyleneoxy units in a defined ratio, preferably about 0.5:1 to about 10:1, and two end-cap units derived from sodium 2-(2-hydroxyethoxy)-ethanesulfonate. Said SRA preferably further comprises from 0.5% to 20%, by weight of the oligomer, of a crystallinity-reducing stabiliser, for example an anionic surfactant such as linear sodium dodecylbenzenesulfonate or a member selected from xylene-, cumene-, and toluene-sulfonates or mixtures thereof, these stabilizers or modifiers being introduced into the

synthesis pot, all as taught in U.S. 5,415,807, Gosselink, Pan, Kellett and Hall, issued May 16, 1995. Suitable monomers for the above SRA include Na 2-(2-hydroxyethoxy)-ethanesulfonate, DMT, Na- dimethyl 5-sulfoisophthalate, EG and PG.

Yet another group of preferred SRA's are oligomeric esters comprising: (1) a backbone comprising (a) at least one unit selected from the group consisting of dihydroxysulfonates, polyhydroxy sulfonates, a unit which is at least trifunctional whereby ester linkages are formed resulting in a branched oligomer backbone, and combinations thereof; (b) at least one unit which is a terephthaloyl moiety; and (c) at least one unsulfonated unit which is a 1,2-oxyalkyleneoxy moiety; and (2) one or more capping units selected from nonionic capping units, anionic capping units such as alkoxyated, preferably ethoxyated, isethionates, alkoxyated propanesulfonates, alkoxyated propanedisulfonates, alkoxyated phenolsulfonates, sulfoaroyl derivatives and mixtures thereof. Preferred of such esters are those of empirical formula:



wherein CAP, EG/PG, PEG, T and SIP are as defined hereinabove, (DEG) represents di(oxyethylene)oxy units; (SEG) represents units derived from the sulfoethyl ether of glycerin and related moiety units; (B) represents branching units which are at least trifunctional whereby ester linkages are formed resulting in a branched oligomer backbone; x is from about 1 to about 12; y' is from about 0.5 to about 25; y'' is from 0 to about 12; y''' is from 0 to about 10; y' + y'' + y''' totals from about 0.5 to about 25; z is from about 1.5 to about 25; z' is from 0 to about 12; z + z' totals from about 1.5 to about 25; q is from about 0.05 to about 12; m is from about 0.01 to about 10; and x, y', y'', y''', z, z', q and m represent the average number of moles of the corresponding units per mole of said ester and said ester has a molecular weight ranging from about 500 to about 5,000.

Preferred SEG and CAP monomers for the above esters include Na-2-(2,3-dihydroxypropoxy)ethanesulfonate ("SEG"), Na-2-{2-(2-hydroxyethoxy) ethoxy} ethanesulfonate ("SE3") and its homologs and mixtures thereof and the products of ethoxylating and sulfonating allyl alcohol. Preferred SRA esters in this class include the product of transesterifying and oligomerizing sodium 2-{2-(2-hydroxyethoxy)ethoxy}ethanesulfonate and/or sodium 2-[2-{2-(2-hydroxyethoxy)-ethoxy}ethoxy]ethanesulfonate, DMT, sodium 2-(2,3-dihydroxypropoxy) ethane sulfonate, EG, and PG using an appropriate Ti(IV) catalyst and can be designated as

(CAP)2(T)5(EG/PG)1.4(SEG)2.5(B)0.13 wherein CAP is (Na+ -O<sub>3</sub>S[CH<sub>2</sub>CH<sub>2</sub>O]3.5)- and B is a unit from glycerin and the mole ratio EG/PG is about 1.7:1 as measured by conventional gas chromatography after complete hydrolysis.

Additional classes of SRA's include (I) nonionic terephthalates using diisocyanate coupling agents to link up polymeric ester structures, see U.S. 4,201,824, Violland et al. and U.S. 4,240,918 Lagasse et al; (II) SRA's with carboxylate terminal groups made by adding trimellitic anhydride to known SRA's to convert terminal hydroxyl groups to trimellitate esters. With a proper selection of catalyst, the trimellitic anhydride forms linkages to the terminals of the polymer through an ester of the isolated carboxylic acid of trimellitic anhydride rather than by opening of the anhydride linkage. Either nonionic or anionic SRA's may be used as starting materials as long as they have hydroxyl terminal groups which may be esterified. See U.S. 4,525,524 Tung et al.; (III) anionic terephthalate-based SRA's of the urethane-linked variety, see U.S. 4,201,824, Violland et al; (IV) poly(vinyl caprolactam) and related co-polymers with monomers such as vinyl pyrrolidone and/or dimethylaminoethyl methacrylate, including both nonionic and cationic polymers, see U.S. 4,579,681, Ruppert et al.; (V) graft copolymers, in addition to the SOKALAN types from BASF made, by grafting acrylic monomers on to sulfonated polyesters; these SRA's assertedly have soil release and anti-redeposition activity similar to known cellulose ethers: see EP 279,134 A, 1988, to Rhone-Poulenc Chemie; (VI) grafts of vinyl monomers such as acrylic acid and vinyl acetate on to proteins such as caseins, see EP 457,205 A to BASF (1991); (VII) polyester-polyamide SRA's prepared by condensing adipic acid, caprolactam, and polyethylene glycol, especially for treating polyamide fabrics, see Bevan et al, DE 2,335,044 to Unilever N. V., 1974. Other useful SRA's are described in U.S. Patents 4,240,918, 4,787,989, 4,525,524 and 4,877,896.

### Clay Soil Removal/Anti-redeposition Agents

The compositions of the present invention can also optionally contain water-soluble ethoxylated amines having clay soil removal and antiredeposition properties. Granular detergent compositions which contain these compounds typically contain from 0.01% to 10.0% by weight of the water-soluble ethoxylated amines; liquid detergent compositions typically contain 0.01% to 5%.

The most preferred soil release and anti-redeposition agent is ethoxylated tetraethylene-pentamine. Exemplary ethoxylated amines are further described in U.S. Patent 4,597,898, VanderMeer, issued July 1, 1986. Another group of preferred clay soil removal-antiredeposition agents are the cationic compounds disclosed in European Patent Application 111,965, Oh and Gosselink, published June 27, 1984. Other clay soil removal/antiredeposition agents which can be used include the ethoxylated amine polymers disclosed in European Patent Application 111,984, Gosselink, published June 27, 1984; the zwitterionic polymers disclosed in European Patent Application 112,592, Gosselink, published July 4, 1984; and the amine oxides disclosed in U.S. Patent 4,548,744, Connor, issued October 22, 1985. Other clay soil removal and/or anti redeposition agents known in the art can also be utilized in the compositions herein. See U.S. Patent 4,891,160, VanderMeer, issued January 2, 1990 and WO 95/32272, published November 30, 1995. Another type of preferred antiredeposition agent includes the carboxy methyl cellulose (CMC) materials. These materials are well known in the art.

### Polymeric Dispersing Agents

Polymeric dispersing agents can advantageously be utilized at levels from 0.1% to 7%, by weight, in the compositions herein, especially in the presence of zeolite and/or layered silicate builders. Suitable polymeric dispersing agents include polymeric polycarboxylates and polyethylene glycols, although others known in the art can also be used. It is believed, though it is not intended to be limited by theory, that polymeric dispersing agents enhance overall detergent builder performance, when used in combination with other builders (including lower molecular weight polycarboxylates) by crystal growth inhibition, particulate soil release peptization, and anti-redeposition.

Polymeric polycarboxylate materials can be prepared by polymerizing or copolymerizing suitable unsaturated monomers, preferably in their acid form. Unsaturated monomeric acids that can be polymerized to form suitable polymeric polycarboxylates include acrylic acid, maleic acid (or maleic anhydride), fumaric acid, itaconic acid, aconitic acid, mesaconic acid, citraconic acid and methylenemalononic acid. The presence in the polymeric polycarboxylates herein or monomeric segments, containing no carboxylate radicals such as vinylmethyl ether, styrene, ethylene, etc. is suitable provided that such segments do not constitute more than 40% by weight.

Particularly suitable polymeric polycarboxylates can be derived from acrylic acid. Such acrylic acid-based polymers which are useful herein are the water-soluble salts of polymerized acrylic acid. The average molecular weight of such polymers in the acid form preferably ranges from 2,000 to 10,000, more preferably from 4,000 to 7,000 and most preferably from 4,000 to 5,000. Water-soluble salts of such acrylic acid polymers can include, for example, the alkali metal, ammonium and substituted ammonium salts. Soluble polymers of this type are known materials. Use of polyacrylates of this type in detergent compositions has been disclosed, for example, in Diehl, U.S. Patent 3,308,067, issued March 7, 1967.

Acrylic/maleic-based copolymers may also be used as a preferred component of the dispersing/anti-redeposition agent. Such materials include the water-soluble salts of copolymers of acrylic acid and maleic acid. The average molecular weight of such copolymers in the acid form preferably ranges from 2,000 to 100,000, more preferably from 5,000 to 75,000, most preferably from 7,000 to 65,000. The ratio of acrylate to maleate segments in such copolymers will generally range from 30:1 to 1:1, more preferably from 10:1 to 2:1. Water-soluble salts of such acrylic acid/maleic acid copolymers can include, for example, the alkali metal, ammonium and substituted ammonium salts. Soluble acrylate/maleate copolymers of this type are known materials which are described in European Patent Application No. 66915, published December 15, 1982, as well as in EP 193,360, published September 3, 1986, which also describes such polymers comprising hydroxypropylacrylate. Still other useful dispersing agents include the maleic/acrylic/vinyl alcohol terpolymers. Such materials are also disclosed in EP 193,360, including, for example, the 45/45/10 terpolymer of acrylic/maleic/vinyl alcohol.

Another polymeric material which can be included is polyethylene glycol (PEG). PEG can exhibit dispersing agent performance as well as act as a clay soil removal-antiredeposition agent. Typical molecular weight ranges for these purposes range from 500 to 100,000, preferably from 1,000 to 50,000, more preferably from 1,500 to 10,000.

Polyaspartate and polyglutamate dispersing agents may also be used, especially in conjunction with zeolite builders. Dispersing agents such as polyaspartate preferably have a molecular weight (avg.) of 10,000.

### Brightener

Any optical brighteners or other brightening or whitening agents known in the art can be incorporated at levels typically from 0.01% to 1.2%, by weight, into the detergent compositions herein. Commercial optical brighteners which may be useful in the present invention can be classified into subgroups, which include, but are not necessarily limited to, derivatives of stilbene, pyrazoline, coumarin, carboxylic acid, methinecyanines, dibenzothiophene-5,5-dioxide, azoles, 5- and 6-membered-ring heterocycles, and other miscellaneous agents. Examples of such brighteners are disclosed in "The Production and Application of Fluorescent Brightening Agents", M. Zahradnik, Published by John Wiley & Sons, New York (1982).

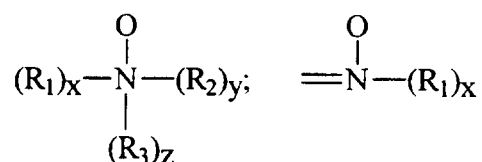
Specific examples of optical brighteners which are useful in the present compositions are those identified in U.S. Patent 4,790,856, issued to Wixon on December 13, 1988. These brighteners include the PHORWHITE series of brighteners from Verona. Other brighteners disclosed in this reference include: Tinopal UNPA, Tinopal CBS and Tinopal 5BM; available from Ciba-Geigy; Artic White CC and Artic White CWD, the 2-(4-styryl-phenyl)-2H-naphtho[1,2-d]triazoles; 4,4'-bis-(1,2,3-triazol-2-yl)-stilbenes; 4,4'-bis(styryl)bisphenyls; and the aminocoumarins. Specific examples of these brighteners include 4-methyl-7-diethyl- amino coumarin; 1,2-bis(benzimidazol-2-yl)ethylene; 1,3-diphenyl-pyrazolines; 2,5-bis(benzoxazol-2-yl)thiophene; 2-styryl-naphtho[1,2-d]oxazole; and 2-(stilben-4-yl)-2H-naphtho[1,2-d]triazole. See also U.S. Patent 3,646,015, issued February 29, 1972 to Hamilton.

### Dye Transfer Inhibiting Agents

The compositions of the present invention may also include one or more materials effective for inhibiting the transfer of dyes from one fabric to another during the cleaning process. Generally, such dye transfer inhibiting agents include polyvinyl pyrrolidone polymers, polyamine N-oxide polymers, copolymers of N-vinylpyrrolidone and N-vinylimidazole, manganese phthalocyanine, peroxidases, and mixtures thereof. If used, these agents typically comprise from 0.01% to 10% by weight of the composition, preferably from 0.01% to 5%, and more preferably from 0.05% to 2%.

More specifically, the polyamine N-oxide polymers preferred for use herein contain units having the following structural formula:  $R-A_x-P$ ; wherein P is a polymerizable unit to which an N-O group can be attached or the N-O group can form part of the polymerizable unit or the N-O group can be attached to both units; A is one of the following structures:  $-NC(O)-$ ,  $-C(O)O-$ ,  $-S-$ ,  $-O-$ ,  $-N=$ ; x is 0 or 1; and R is aliphatic, ethoxylated aliphatics, aromatics, heterocyclic or alicyclic groups or any combination thereof to which the nitrogen of the N-O group can be attached or the N-O group is part of these groups. Preferred polyamine N-oxides are those wherein R is a heterocyclic group such as pyridine, pyrrole, imidazole, pyrrolidine, piperidine and derivatives thereof.

The N-O group can be represented by the following general structures:



wherein  $R_1$ ,  $R_2$ ,  $R_3$  are aliphatic, aromatic, heterocyclic or alicyclic groups or combinations thereof; x, y and z are 0 or 1; and the nitrogen of the N-O group can be attached or form part of any of the aforementioned groups. The amine oxide unit of the polyamine N-oxides has a  $pK_a < 10$ , preferably  $pK_a < 7$ , more preferred  $pK_a < 6$ .

Any polymer backbone can be used as long as the amine oxide polymer formed is water-soluble and has dye transfer inhibiting properties. Examples of suitable polymeric backbones are polyvinyls, polyalkylenes, polyesters, polyethers, polyamide, polyimides, polyacrylates and mixtures thereof. These polymers include random or block copolymers where one monomer type is an amine N-oxide and the other monomer



type is an N-oxide. The amine N-oxide polymers typically have a ratio of amine to the amine N-oxide of 10:1 to 1:1,000,000. However, the number of amine oxide groups present in the polyamine oxide polymer can be varied by appropriate copolymerization or by an appropriate degree of N-oxidation. The polyamine oxides can be obtained in almost any degree of polymerization. Typically, the average molecular weight is within the range of 500 to 1,000,000; more preferred 1,000 to 500,000; most preferred 5,000 to 100,000. This preferred class of materials can be referred to as "PVNO".

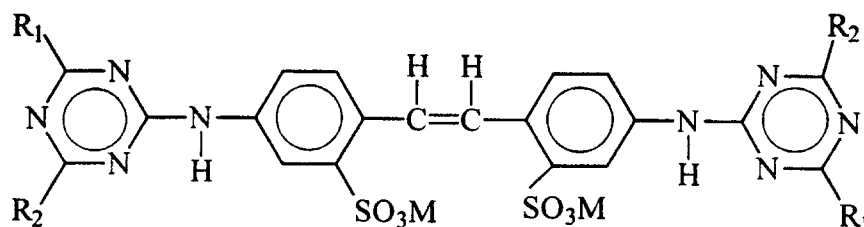
The most preferred polyamine N-oxide useful in the detergent compositions herein is poly(4-vinylpyridine-N-oxide) which has an average molecular weight of 50,000 and an amine to amine N-oxide ratio of 1:4.

Copolymers of N-vinylpyrrolidone and N-vinylimidazole polymers (referred to as a class as "PVPVI") are also preferred for use herein. Preferably the PVPVI has an average molecular weight range from 5,000 to 1,000,000, more preferably from 5,000 to 200,000, and most preferably from 10,000 to 20,000. (The average molecular weight range is determined by light scattering as described in Barth, et al., Chemical Analysis, Vol 113. "Modern Methods of Polymer Characterization", the disclosures of which are incorporated herein by reference.) The PVPVI copolymers typically have a molar ratio of N-vinylimidazole to N-vinylpyrrolidone from 1:1 to 0.2:1, more preferably from 0.8:1 to 0.3:1, most preferably from 0.6:1 to 0.4:1. These copolymers can be either linear or branched.

The present invention compositions also may employ a polyvinylpyrrolidone ("PVP") having an average molecular weight of from 5,000 to 400,000, preferably from 5,000 to 200,000, and more preferably from 5,000 to 50,000. PVP's are known to persons skilled in the detergent field; see, for example, EP-A-262,897 and EP-A-256,696, incorporated herein by reference. Compositions containing PVP can also contain polyethylene glycol ("PEG") having an average molecular weight from 500 to 100,000, preferably from 1,000 to 10,000. Preferably, the ratio of PEG to PVP on a ppm basis delivered in wash solutions is from 2:1 to 50:1, and more preferably from 3:1 to 10:1.

The detergent compositions herein may also optionally contain from 0.005% to 5% by weight of certain types of hydrophilic optical brighteners which also provide a dye transfer inhibition action. If used, the compositions herein will preferably comprise from 0.01% to 1% by weight of such optical brighteners.

The hydrophilic optical brighteners useful in the present invention are those having the structural formula:



wherein R<sub>1</sub> is selected from anilino, N-2-bis-hydroxyethyl and NH-2-hydroxyethyl; R<sub>2</sub> is selected from N-2-bis-hydroxyethyl, N-2-hydroxyethyl-N-methylamino, morphilino, chloro and amino; and M is a salt-forming cation such as sodium or potassium.

When in the above formula, R<sub>1</sub> is anilino, R<sub>2</sub> is N-2-bis-hydroxyethyl and M is a cation such as sodium, the brightener is 4,4',-bis[(4-anilino-6-(N-2-bis-hydroxyethyl)-s-triazine-2-yl)amino]-2,2'-stilbenedisulfonic acid and disodium salt. This particular brightener species is commercially marketed under the tradename Tinopal-UNPA-GX by Ciba-Geigy Corporation. Tinopal-UNPA-GX is the preferred hydrophilic optical brightener useful in the detergent compositions herein.

When in the above formula, R<sub>1</sub> is anilino, R<sub>2</sub> is N-2-hydroxyethyl-N-2-methylamino and M is a cation such as sodium, the brightener is 4,4'-bis[(4-anilino-6-(N-2-hydroxyethyl-N-methylamino)-s-triazine-2-yl)amino]2,2'-stilbenedisulfonic acid disodium salt. This particular brightener species is commercially marketed under the tradename Tinopal 5BM-GX by Ciba-Geigy Corporation.

When in the above formula, R<sub>1</sub> is anilino, R<sub>2</sub> is morphilino and M is a cation such as sodium, the brightener is 4,4'-bis[(4-anilino-6-morphilino-s-triazine-2-yl)amino]2,2'-stilbenedisulfonic acid, sodium salt. This particular brightener species is commercially marketed under the tradename Tinopal AMS-GX by Ciba Geigy Corporation.

The specific optical brightener species selected for use in the present invention provide especially effective dye transfer inhibition performance benefits when used in combination with the selected polymeric dye transfer inhibiting agents hereinbefore described. The combination of such selected polymeric materials (e.g., PVNO and/or

PVPVI) with such selected optical brighteners (e.g., Tinopal UNPA-GX, Tinopal 5BM-GX and/or Tinopal AMS-GX) provides significantly better dye transfer inhibition in aqueous wash solutions than does either of these two detergent composition components when used alone. Without being bound by theory, it is believed that such brighteners work this way because they have high affinity for fabrics in the wash solution and therefore deposit relatively quick on these fabrics. The extent to which brighteners deposit on fabrics in the wash solution can be defined by a parameter called the "exhaustion coefficient". The exhaustion coefficient is in general as the ratio of a) the brightener material deposited on fabric to b) the initial brightener concentration in the wash liquor. Brighteners with relatively high exhaustion coefficients are the most suitable for inhibiting dye transfer in the context of the present invention.

Of course, it will be appreciated that other, conventional optical brightener types of compounds can optionally be used in the present compositions to provide conventional fabric "brightness" benefits, rather than a true dye transfer inhibiting effect. Such usage is conventional and well-known to detergent formulations.

#### Chelating Agents

The detergent compositions herein may also optionally contain one or more iron and/or manganese chelating agents. Such chelating agents can be selected from the group consisting of amino carboxylates, amino phosphonates, polyfunctionally-substituted aromatic chelating agents and mixtures therein, all as hereinafter defined. Without intending to be bound by theory, it is believed that the benefit of these materials is due in part to their exceptional ability to remove iron and manganese ions from washing solutions by formation of soluble chelates.

Amino carboxylates useful as optional chelating agents include ethylenediaminetetraacetates, N-hydroxyethylethylenediaminetriacetates, nitrilotriacetates, ethylenediamine tetrapropionates, triethylenetetraaminehexacetates, diethylenetriaminepentaacetates, and ethanoldiglycines, alkali metal, ammonium, and substituted ammonium salts therein and mixtures therein.

Amino phosphonates are also suitable for use as chelating agents in the compositions of the invention when at least low levels of total phosphorus are permitted in detergent compositions, and include ethylenediaminetetrakis (methylenephosphonates) as

DEQUEST. Preferred, these amino phosphonates to not contain alkyl or alkenyl groups with more than 6 carbon atoms.

Polyfunctionally-substituted aromatic chelating agents are also useful in the compositions herein. See U.S. Patent 3,812,044, issued May 21, 1974, to Connor et al. Preferred compounds of this type in acid form are dihydroxydisulfobenzenes such as 1,2-dihydroxy-3,5-disulfobenzene.

A preferred biodegradable chelator for use herein is ethylenediamine disuccinate ("EDDS"), especially the [S,S] isomer as described in U.S. Patent 4,704,233, November 3, 1987, to Hartman and Perkins.

The compositions herein may also contain water-soluble methyl glycine diacetic acid (MGDA) salts (or acid form) as a chelant or co-builder useful with, for example, insoluble builders such as zeolites, layered silicates.

If utilized, these chelating agents will generally comprise from 0.1% to 15% by weight of the detergent compositions herein. More preferably, if utilized, the chelating agents will comprise from 0.1% to 3.0% by weight of such compositions.

### Suds Suppressors

Compounds for reducing or suppressing the formation of suds can be incorporated into the compositions of the present invention. Suds suppression can be of particular importance in the so-called "high concentration cleaning process" as described in U.S. 4,489,455 and 4,489,574 and in front-loading European-style washing machines.

A wide variety of materials may be used as suds suppressors, and suds suppressors are well known to those skilled in the art. See, for example, Kirk Othmer Encyclopedia of Chemical Technology, Third Edition, Volume 7, pages 430-447 (John Wiley & Sons, Inc., 1979). One category of suds suppressor of particular interest encompasses monocarboxylic fatty acid and soluble salts therein. See U.S. Patent 2,954,347, issued September 27, 1960 to Wayne St. John. The monocarboxylic fatty acids and salts thereof used as suds suppressor typically have hydrocarbyl chains of 10 to 24 carbon atoms, preferably 12 to 18 carbon atoms. Suitable salts include the alkali metal salts such as sodium, potassium, and lithium salts, and ammonium and alkanolammonium salts.

The detergent compositions herein may also contain non-surfactant suds suppressors. These include, for example: high molecular weight hydrocarbons such as paraffin, fatty acid esters (e.g., fatty acid triglycerides), fatty acid esters of monovalent alcohols, aliphatic C<sub>18</sub>-C<sub>40</sub> ketones (e.g., stearone), etc. Other suds inhibitors include N-alkylated amino triazines such as tri- to hexa-alkylmelamines or di- to tetra-alkyldiamine chlorotriazines formed as products of cyanuric chloride with two or three moles of a primary or secondary amine containing 1 to 24 carbon atoms, propylene oxide, and monostearyl phosphates such as monostearyl alcohol phosphate ester and monostearyl di-alkali metal (e.g., K, Na, and Li) phosphates and phosphate esters. The hydrocarbons such as paraffin and haloparaffin can be utilized in liquid form. The liquid hydrocarbons will be liquid at room temperature and atmospheric pressure, and will have a pour point in the range of -40°C and 50°C, and a minimum boiling point not less than 110°C (atmospheric pressure). It is also known to utilize waxy hydrocarbons, preferably having a melting point below 100°C. The hydrocarbons constitute a preferred category of suds suppressor for detergent compositions. Hydrocarbon suds suppressors are described, for example, in U.S. Patent 4,265,779, issued May 5, 1981 to Gandolfo et al. The hydrocarbons, thus, include aliphatic, alicyclic, aromatic, and heterocyclic saturated or unsaturated hydrocarbons having from

12 to 70 carbon atoms. The term "paraffin," as used in this suds suppressor discussion, is intended to include mixtures of true paraffins and cyclic hydrocarbons.

Another preferred category of non-surfactant suds suppressors comprises silicone suds suppressors. This category includes the use of polyorganosiloxane oils, such as polydimethylsiloxane, dispersions or emulsions of polyorganosiloxane oils or resins, and combinations of polyorganosiloxane with silica particles wherein the polyorganosiloxane is chemisorbed or fused onto the silica. Silicone suds suppressors are well known in the art and are, for example, disclosed in U.S. Patent 4,265,779, issued May 5, 1981 to Gandolfo et al and European Patent Application No. 89307851.9, published February 7, 1990, by Starch, M. S.

Other silicone suds suppressors are disclosed in U.S. Patent 3,455,839 which relates to compositions and processes for defoaming aqueous solutions by incorporating therein small amounts of polydimethylsiloxane fluids.

Mixtures of silicone and silanated silica are described, for instance, in German Patent Application DOS 2,124,526. Silicone defoamers and suds controlling agents in granular detergent compositions are disclosed in U.S. Patent 3,933,672, Bartolotta et al, and in U.S. Patent 4,652,392, Baginski et al, issued March 24, 1987.

An exemplary silicone based suds suppressor for use herein is a suds suppressing amount of a suds controlling agent consisting essentially of:

- (i) polydimethylsiloxane fluid having a viscosity of from about 20 cs. to about 1,500 cs. at 25°C;
- (ii) from about 5 to about 50 parts per 100 parts by weight of (i) of siloxane resin composed of  $(\text{CH}_3)_3\text{SiO}_{1/2}$  units of  $\text{SiO}_2$  units in a ratio of from  $(\text{CH}_3)_3\text{SiO}_{1/2}$  units and to  $\text{SiO}_2$  units of from about 0.6:1 to about 1.2:1; and
- (iii) from about 1 to about 20 parts per 100 parts by weight of (i) of a solid silica gel.

In the preferred silicone suds suppressor used herein, the solvent for a continuous phase is made up of certain polyethylene glycols or polyethylene-polypropylene glycol copolymers or mixtures thereof (preferred), or polypropylene glycol. The primary silicone suds suppressor is branched/crosslinked and preferably not linear.

To illustrate this point further, typical liquid laundry detergent compositions with controlled suds will optionally comprise from about 0.001 to about 1, preferably from about 0.01 to about 0.7, most preferably from about 0.05 to about 0.5, weight % of said silicone suds suppressor, which comprises (1) a nonaqueous emulsion of a primary antifoam agent which is a mixture of (a) a polyorganosiloxane, (b) a resinous siloxane or a silicone resin-producing silicone compound, (c) a finely divided filler material, and (d) a catalyst to promote the reaction of mixture components (a), (b) and (c), to form silanolates; (2) at least one nonionic silicone surfactant; and (3) polyethylene glycol or a copolymer of polyethylene-polypropylene glycol having a solubility in water at room temperature of more than about 2 weight %; and without polypropylene glycol. Similar amounts can be used in granular compositions, gels, etc. See also U.S. Patents 4,978,471, Starch, issued December 18, 1990, and 4,983,316, Starch, issued January 8, 1991, 5,288,431, Huber et al., issued February 22, 1994, and U.S. Patents 4,639,489 and 4,749,740, Aizawa et al at column 1, line 46 through column 4, line 35.

The silicone suds suppressor herein preferably comprises polyethylene glycol and a copolymer of polyethylene glycol/polypropylene glycol, all having an average molecular weight of less than about 1,000, preferably between about 100 and 800. The polyethylene glycol and polyethylene/polypropylene copolymers herein have a solubility in water at room temperature of more than about 2 weight %, preferably more than about 5 weight %.

The preferred solvent herein is polyethylene glycol having an average molecular weight of less than about 1,000, more preferably between about 100 and 800, most preferably between 200 and 400, and a copolymer of polyethylene glycol/polypropylene glycol, preferably PPG 200/PEG 300. Preferred is a weight ratio of between about 1:1 and 1:10, most preferably between 1:3 and 1:6, of polyethylene glycol:copolymer of polyethylene-polypropylene glycol.

The preferred silicone suds suppressors used herein do not contain polypropylene glycol, particularly of 4,000 molecular weight. They also preferably do not contain block copolymers of ethylene oxide and propylene oxide, like PLURONIC L101.

Other suds suppressors useful herein comprise the secondary alcohols (e.g., 2-alkyl alkanols) and mixtures of such alcohols with silicone oils, such as the silicones

disclosed in U.S. 4,798,679, 4,075,118 and EP 150,872. The secondary alcohols include the C<sub>6</sub>-C<sub>16</sub> alkyl alcohols having a C<sub>1</sub>-C<sub>16</sub> chain. A preferred alcohol is 2-butyl octanol, which is available from Condea under the trademark ISOFOL 12. Mixtures of secondary alcohols are available under the trademark ISALCHEM 123 from Enichem. Mixed suds suppressors typically comprise mixtures of alcohol + silicone at a weight ratio of 1:5 to 5:1.

For any detergent compositions to be used in automatic laundry or dishwashing machines, suds should not form to the extent that they either overflow the washing machine or negatively affect the washing mechanism of the dishwasher. Suds suppressors, when utilized, are preferably present in a "suds suppressing amount. By "suds suppressing amount" is meant that the formulator of the composition can select an amount of this suds controlling agent that will sufficiently control the suds to result in a low-sudsing laundry or dishwashing detergents for use in automatic laundry or dishwashing machines.

The compositions herein will generally comprise from 0% to 10% of suds suppressor. When utilized as suds suppressors, monocarboxylic fatty acids, and salts therein, will be present typically in amounts up to 5%, by weight, of the detergent composition. Preferably, from 0.5% to 3% of fatty monocarboxylate suds suppressor is utilized. Silicone suds suppressors are typically utilized in amounts up to 2.0%, by weight, of the detergent composition, although higher amounts may be used. This upper limit is practical in nature, due primarily to concern with keeping costs minimized and effectiveness of lower amounts for effectively controlling sudsing. Preferably from 0.01% to 1% of silicone suds suppressor is used, more preferably from 0.25% to 0.5%. As used herein, these weight percentage values include any silica that may be utilized in combination with polyorganosiloxane, as well as any optional materials that may be utilized. Monostearyl phosphate suds suppressors are generally utilized in amounts ranging from 0.1% to 2%, by weight, of the composition. Hydrocarbon suds suppressors are typically utilized in amounts ranging from 0.01% to 5.0%, although higher levels can be used. The alcohol suds suppressors are typically used at 0.2%-3% by weight of the finished compositions.

#### Alkoxyated Polycarboxylates



Alkoxyated polycarboxylates such as those prepared from polyacrylates are useful herein to provide additional grease removal performance. Such materials are described in WO 91/08281 and PCT 90/01815 at p. 4 et seq., incorporated herein by reference. Chemically, these materials comprise polyacrylates having one ethoxy side-chain per every 7-8 acrylate units. The side-chains are of the formula  $-(\text{CH}_2\text{CH}_2\text{O})_m(\text{CH}_2)_n\text{CH}_3$  wherein m is 2-3 and n is 6-12. The side-chains are ester-linked to the polyacrylate "backbone" to provide a "comb" polymer type structure. The molecular weight can vary, but is typically in the range of 2000 to 50,000. Such alkoxyated polycarboxylates can comprise from 0.05% to 10%, by weight, of the compositions herein.

### Fabric Softeners

Various through-the-wash fabric softeners, especially the impalpable smectite clays of U.S. Patent 4,062,647, Storm and Nirschl, issued December 13, 1977, as well as other softener clays known in the art, can optionally be used typically at levels of from 0.5% to 10% by weight in the present compositions to provide fabric softener benefits concurrently with fabric cleaning. Clay softeners can be used in combination with amine and cationic softeners as disclosed, for example, in U.S. Patent 4,375,416, Crisp et al, March 1, 1983 and U.S. Patent 4,291,071, Harris et al, issued September 22, 1981

### Perfumes

Perfumes and perfumery ingredients useful in the present compositions and processes comprise a wide variety of natural and synthetic chemical ingredients, including, but not limited to, aldehydes, ketones, esters. Also included are various natural extracts and essences which can comprise complex mixtures of ingredients, such as orange oil, lemon oil, rose extract, lavender, musk, patchouli, balsamic essence, sandalwood oil, pine oil, cedar. Finished perfumes can comprise extremely complex mixtures of such ingredients. Finished perfumes typically comprise from 0.01% to 2%, by weight, of the detergent compositions herein, and individual perfumery ingredients can comprise from 0.0001% to 90% of a finished perfume composition.

Non-limiting examples of perfume ingredients useful herein include: 7-acetyl-1,2,3,4,5,6,7,8-octahydro-1,1,6,7-tetramethyl naphthalene; ionone methyl; ionone

gamma methyl; methyl cedrylone; methyl dihydrojasmonate; methyl 1,6,10-trimethyl-2,5,9-cyclododecatrien-1-yl ketone; 7-acetyl-1,1,3,4,4,6-hexamethyl tetralin; 4-acetyl-6-tert-butyl-1,1-dimethyl indane; para-hydroxy-phenyl-butanone; benzophenone; methyl beta-naphthyl ketone; 6-acetyl-1,1,2,3,3,5-hexamethyl indane; 5-acetyl-3-isopropyl-1,1,2,6-tetramethyl indane; 1-dodecanal, 4-(4-hydroxy-4-methylpentyl)-3-cyclohexene-1-carboxaldehyde; 7-hydroxy-3,7-dimethyl octanal; 10-undecen-1-al; iso-hexenyl cyclohexyl carboxaldehyde; formyl tricyclodecane; condensation products of hydroxycitronellal and methyl anthranilate, condensation products of hydroxycitronellal and indol, condensation products of phenyl acetaldehyde and indol; 2-methyl-3-(para-tert-butylphenyl)-propionaldehyde; ethyl vanillin; heliotropin; hexyl cinnamic aldehyde; amyl cinnamic aldehyde; 2-methyl-2-(para-iso-propylphenyl)-propionaldehyde; coumarin; decalactone gamma; cyclopentadecanolide; 16-hydroxy-9-hexadecenoic acid lactone; 1,3,4,6,7,8-hexahydro-4,6,6,7,8,8-hexamethylcyclopenta-gamma-2-benzopyrane; beta-naphthol methyl ether; ambroxane; dodecahydro-3a,6,6,9a-tetramethylnaphtho[2,1b]furan; cedrol, 5-(2,2,3-trimethylcyclopent-3-enyl)-3-methylpentan-2-ol; 2-ethyl-4-(2,2,3-trimethyl-3-cyclopenten-1-yl)-2-buten-1-ol; caryophyllene alcohol; tricyclodecenyl propionate; tricyclodecenyl acetate; benzyl salicylate; cedryl acetate; and para-(tert-butyl) cyclohexyl acetate.

Particularly preferred perfume materials are those that provide the largest odor improvements in finished product compositions containing cellulases. These perfumes include but are not limited to: hexyl cinnamic aldehyde; 2-methyl-3-(para-tert-butylphenyl)-propionaldehyde; 7-acetyl-1,2,3,4,5,6,7,8-octahydro-1,1,6,7-tetramethyl naphthalene; benzyl salicylate; 7-acetyl-1,1,3,4,4,6-hexamethyl tetralin; para-tert-butyl cyclohexyl acetate; methyl dihydro jasmonate; beta-naphthol methyl ether; methyl beta-naphthyl ketone; 2-methyl-2-(para-iso-propylphenyl)-propionaldehyde; 1,3,4,6,7,8-hexahydro-4,6,6,7,8,8-hexamethyl-cyclopenta-gamma-2-benzopyrane; dodecahydro-3a,6,6,9a-tetramethylnaphtho[2,1b]furan; anisaldehyde; coumarin; cedrol; vanillin; cyclopentadecanolide; tricyclodecenyl acetate; and tricyclodecenyl propionate.

Other perfume materials include essential oils, resinoids, and resins from a variety of sources including, but not limited to: Peru balsam, Olibanum resinoid, styrax, labdanum resin, nutmeg, cassia oil, benzoin resin, coriander and lavandin. Still other perfume chemicals include phenyl ethyl alcohol, terpineol, linalool, linalyl acetate, geraniol, nerol, 2-(1,1-dimethylethyl)-cyclohexanol acetate, benzyl acetate, and

eugenol. Carriers such as diethylphthalate can be used in the finished perfume compositions.

### Other Ingredients

A wide variety of other ingredients useful in detergent compositions can be included in the compositions herein, including other active ingredients, carriers, hydrotropes, processing aids, dyes or pigments, solvents for liquid formulations, solid fillers for bar compositions, etc. If high sudsing is desired, suds boosters such as the C<sub>10</sub>-C<sub>16</sub> alkanolamides can be incorporated into the compositions, typically at 1%-10% levels. The C<sub>10</sub>-C<sub>14</sub> monoethanol and diethanol amides illustrate a typical class of such suds boosters. Use of such suds boosters with high sudsing optional surfactants such as the amine oxides, betaines and sultaines noted above is also advantageous. If desired, water-soluble magnesium and/or calcium salts such as MgCl<sub>2</sub>, MgSO<sub>4</sub>, CaCl<sub>2</sub> CaSO<sub>4</sub>, can be added at levels of, typically, 0.1%-2%, to provide additional suds and to enhance grease removal performance.

Various deterative ingredients employed in the present compositions optionally can be further stabilized by absorbing said ingredients onto a porous hydrophobic substrate, then coating said substrate with a hydrophobic coating. Preferably, the deterative ingredient is admixed with a surfactant before being absorbed into the porous substrate. In use, the deterative ingredient is released from the substrate into the aqueous washing liquor, where it performs its intended deterative function.

To illustrate this technique in more detail, a porous hydrophobic silica (trademark SIPERNAT D10, DeGussa) is admixed with a proteolytic enzyme solution containing 3%-5% of C<sub>13-15</sub> ethoxylated alcohol (EO 7) nonionic surfactant. Typically, the enzyme/surfactant solution is 2.5 X the weight of silica. The resulting powder is dispersed with stirring in silicone oil (various silicone oil viscosities in the range of 500-12,500 can be used). The resulting silicone oil dispersion is emulsified or otherwise added to the final detergent matrix. By this means, ingredients such as the aforementioned enzymes, bleaches, bleach activators, bleach catalysts, photoactivators, dyes, fluorescers, fabric conditioners and hydrolyzable surfactants can be "protected" for use in detergents, including liquid laundry detergent compositions.

Liquid detergent compositions can contain water and other solvents as carriers. Low molecular weight primary or secondary alcohols exemplified by methanol, ethanol, propanol, and isopropanol are suitable. Monohydric alcohols are preferred for solubilizing surfactant, but polyols such as those containing from 2 to 6 carbon atoms and from 2 to 6 hydroxy groups (e.g., 1,3-propanediol, ethylene glycol, glycerine, and 1,2-propanediol) can also be used. The compositions may contain from 5% to 90%, typically 10% to 50% of such carriers.

The detergent compositions herein will preferably be formulated such that, during use in aqueous cleaning operations, the wash water will have a pH of between 6.5 and 11, preferably between 7.5 and 10.5. Liquid dishwashing product formulations preferably have a pH between 6.8 and 9.0. Laundry products are typically at pH 9-11. Techniques for controlling pH at recommended usage levels include the use of buffers, alkalis, acids, etc., and are well known to those skilled in the art.

#### Granules Manufacture

Adding the bis-alkoxylated cationics of this invention into a crutcher mix, followed by conventional spray drying, helps remove any residual, potentially malodorous, short-chain amine contaminants. In the event the formulator wishes to prepare an admixable particle containing the alkoxylated cationics for use in, for example, a high density granular detergent, it is preferred that the particle composition not be highly alkaline. Processes for preparing high density (above 650 g/l) granules are described in U.S. Patent 5,366,652. Such particles may be formulated to have an effective pH in-use of 9, or below, to avoid the odor of impurity amines. This can be achieved by adding a small amount of acidity source such as boric acid, citric acid, or the like, or an appropriate pH buffer, to the particle. In an alternate mode, the prospective problems associated with amine malodors can be masked by use of perfume ingredients, as disclosed herein.

#### Examples

The following examples are illustrative of the present invention, but are not meant to limit or otherwise define its scope. All parts, percentages and ratios used herein are expressed as percent weight unless otherwise specified.

In the following examples, the abbreviated component identifications have the following meanings:

LAS	:	Sodium linear C <sub>12</sub> alkyl benzene sulfonate
TAS	:	Sodium tallow alkyl sulfate
C45AS	:	Sodium C <sub>14</sub> -C <sub>15</sub> linear alkyl sulfate
C <sub>xy</sub> E <sub>z</sub> S	:	Sodium C <sub>1x</sub> -C <sub>1y</sub> branched alkyl sulfate condensed with z moles of ethylene oxide
C45E7	:	A C <sub>14-15</sub> predominantly linear primary alcohol condensed with an average of 7 moles of ethylene oxide
C25E3	:	A C <sub>12-15</sub> branched primary alcohol condensed with an average of 3 moles of ethylene oxide
C25E5	:	A C <sub>12-15</sub> branched primary alcohol condensed with an average of 5 moles of ethylene oxide
CocoEO2	:	R <sub>1</sub> .N <sup>+</sup> (CH <sub>3</sub> )(C <sub>2</sub> H <sub>4</sub> OH) <sub>2</sub> with R <sub>1</sub> = C <sub>12</sub> - C <sub>14</sub>
Soap	:	Sodium linear alkyl carboxylate derived from an 80/20 mixture of tallow and coconut oils.
TFAA	:	C <sub>16</sub> -C <sub>18</sub> alkyl N-methyl glucamide
TPKFA	:	C <sub>12</sub> -C <sub>14</sub> topped whole cut fatty acids
STPP	:	Anhydrous sodium tripolyphosphate
Zeolite A	:	Hydrated Sodium Aluminosilicate of formula Na <sub>12</sub> (Al <sub>10</sub> Si <sub>2</sub> O <sub>2</sub> ) <sub>12</sub> . 27H <sub>2</sub> O having a primary particle size in the range from 0.1 to 10 micrometers
NaSKS-6	:	Crystalline layered silicate of formula δ -Na <sub>2</sub> Si <sub>2</sub> O <sub>5</sub>
Citric acid	:	Anhydrous citric acid
Carbonate	:	Anhydrous sodium carbonate with a particle size between 200μm and 900μm
Bicarbonate	:	Anhydrous sodium bicarbonate with a particle size distribution between 400μm and 1200μm
Silicate	:	Amorphous Sodium Silicate (SiO <sub>2</sub> :Na <sub>2</sub> O; 2.0 ratio)

Sodium sulfate	:	Anhydrous sodium sulfate
Citrate	:	Tri-sodium citrate dihydrate of activity 86.4% with a particle size distribution between 425µm and 850 µm
MA/AA	:	Copolymer of 1:4 maleic/acrylic acid, average molecular weight 70,000.
CMC	:	Sodium carboxymethyl cellulose
Protease	:	Proteolytic enzyme of activity 4KNPU/g sold by NOVO Industries A/S under the tradename Savinase
Alcalase	:	Proteolytic enzyme of activity 3AU/g sold by NOVO Industries A/S
Cellulase	:	Cellulytic enzyme of activity 1000 CEVU/g sold by NOVO Industries A/S under the tradename Carezyme
Amylase	:	Amylolytic enzyme of activity 60KNU/g sold by NOVO Industries A/S under the tradename Termamyl 60T
Lipase	:	Lipolytic enzyme of activity 100kLU/g sold by NOVO Industries A/S under the tradename Lipolase
Endolase	:	Endoglunase enzyme of activity 3000 CEVU/g sold by NOVO Industries A/S
PB4	:	Sodium perborate tetrahydrate of nominal formula $\text{NaBO}_2 \cdot 3\text{H}_2\text{O} \cdot \text{H}_2\text{O}_2$
PB1	:	Anhydrous sodium perborate bleach of nominal formula $\text{NaBO}_2 \cdot \text{H}_2\text{O}_2$
Percarbonate	:	Sodium Percarbonate of nominal formula $2\text{Na}_2\text{CO}_3 \cdot 3\text{H}_2\text{O}_2$
NOBS	:	Nonanoyloxybenzene sulfonate in the form of the sodium salt.
TAED	:	Tetraacetylenediamine
NACA-OBS	:	(6 nonanamido caproyl) oxybenzene sulphonate
DTPMP	:	Diethylene triamine penta (methylene

- phosphonate), marketed by Monsanto under the Trade name Dequest 2060
- Co Catalyst : Pentaamine acetate cobalt (III) salt
- Mn Catalyst :  $Mn^{IV}_2(m-O)_3(1,4,7\text{-trimethyl-1,4,7-triazacyclononane})_2\text{-}(PF_6)_2$  as described in U.S. pat. nos 5 246 621 and 5 244 594
- Photoactivated : Sulfonated Zinc Phthalocyanine encapsulated in bleach dextrin soluble polymer
- Brightener 1 : Disodium 4,4'-bis(2-sulphostyryl)biphenyl
- Brightener 2 : Disodium 4,4'-bis(4-anilino-6-morpholino-1.3.5-triazin-2-yl)amino) stilbene-2:2'-disulfonate.
- HEDP : 1,1-hydroxyethane diphosphonic acid
- PVNO : Polyvinylpyridine N-oxide
- PVPVI : Copolymer of polyvinylpyrrolidone and vinylimidazole
- SRA 1 : Sulfobenzoyl end capped esters with oxyethylene oxy and terephthaloyl backbone
- SRA 2 : Diethoxylated poly (1, 2 propylene terephthalate) short block polymer
- Silicone antifoam : Polydimethylsiloxane foam controller with siloxane-oxyalkylene copolymer as dispersing agent with a ratio of said foam controller to said dispersing agent of 10:1 to 100:1.

In the following Examples all levels are quoted as % by weight of the composition.

EXAMPLE I

The following detergent formulations according to the present invention are prepared, where A and C are phosphorus-containing detergent compositions and B is a zeolite-containing detergent composition.

	<u>A</u>	<u>B</u>	<u>C</u>
<b>Blown Powder</b>			
STPP	24.0	-	24.0
Zeolite A	-	24.0	-
C45AS	8.0	5.0	11.0
MA/AA	2.0	4.0	2.0
LAS	6.0	8.0	11.0
TAS	1.5	-	-
CocoMeEO2*	1.5	1.0	2.0
Silicate	7.0	3.0	3.0
CMC	1.0	1.0	0.5
Brightener 2	0.2	0.2	0.2
Soap	1.0	1.0	1.0
DTPMP	0.4	0.4	0.2
<b>Spray On</b>			
C45E7	2.5	2.5	2.0
C25E3	2.5	2.5	2.0
Silicone antifoam	0.3	0.3	0.3
Perfume	0.3	0.3	0.3
<b>Dry additives</b>			
Carbonate	6.0	13.0	15.0
PB4	18.0	18.0	10.0
PB1	4.0	4.0	0
TAED	3.0	3.0	1.0
Mn Catalyst	0.3	0.05	0.4
Photoactivated bleach	0.02	0.02	0.02
Protease	1.0	1.0	1.0
Lipase	0.4	0.4	0.4
Amylase	0.25	0.30	0.15
Dry mixed sodium sulfate	3.0	3.0	5.0
Balance (Moisture & Miscellaneous)	To: 100.0	100.0	100.0



Density (g/litre)                      630                      670                      670

\*The AQA-1 (CocoMeEO2) surfactant of the Example may be replaced by an equivalent amount of any of surfactants AQA-2 through AQA-22 or other AQA surfactants herein.

### EXAMPLE II

The following detergent formulations, according to the present invention are prepared:

	<u>G</u>	<u>H</u>	<u>I</u>
<b>Blown Powder</b>			
Zeolite A	30.0	22.0	6.0
Sodium sulfate	19.0	5.0	7.0
MA/AA	3.0	3.0	6.0
LAS	13.0	11.0	21.0
C45AS	8.0	7.0	7.0
CocoMeEO2*	1.0	1.0	1.0
Mn Catalyst	0.9	0.7	0.05
Silicate	-	1.0	5.0
Soap	-	-	2.0
Brightener 1	0.2	0.2	0.2
Carbonate	8.0	16.0	20.0
DTPMP	-	0.4	0.4
<b>Spray On</b>			
C45E7	1.0	1.0	1.0
<b>Dry additives</b>			
PVPVI/PVNO	0.5	0.5	0.5
Protease	1.0	1.0	1.0
Lipase	0.4	0.4	0.4
Amylase	0.1	0.1	0.1
Cellulase	0.1	0.1	0.1
NOBS	-	6.1	4.5
PB1	1.0	5.0	6.0
Sodium sulfate	-	6.0	-
Balance (Moisture & Miscellaneous)	To: 100	100	100

\*The AQA-1 (CocoMeEO2) surfactant of the Example may be replaced by an equivalent amount of any of surfactants AQA-2 through AQA-22 or other AQA surfactants herein.

### EXAMPLE III

The following high density and bleach-containing detergent formulations, according to the present invention are prepared:

	<u>I</u>	<u>K</u>	<u>L</u>
<b>Blown Powder</b>			
Zeolite A	15.0	15.0	15.0
Sodium sulfate	0.0	5.0	0.0
LAS	3.0	3.0	3.0
CocoMeEO2*	1.0	1.5	1.5
DTPMP	0.4	0.4	0.4
CMC	0.4	0.4	0.4
MA/AA	4.0	2.0	2.0
<b>Agglomerates</b>			
LAS	5.0	5.0	5.0
TAS	2.0	2.0	1.0
Silicate	3.0	3.0	4.0
Zeolite A	8.0	8.0	8.0
Carbonate	8.0	8.0	4.0
<b>Spray On</b>			
Perfume	0.3	0.3	0.3
C45E7	2.0	2.0	2.0
C25E3	2.0	-	-
<b>Dry additives</b>			
Citrate	5.0	-	2.0
Bicarbonate	-	3.0	-
Carbonate	8.0	15.0	10.0
TAED	6.0	2.0	5.0
PB1	13.0	7.0	10.0
Mn Catalyst	0.02	0.4	0.1
Polyethylene oxide of MW 5,000,000	-	-	0.2
Bentonite clay	-	-	10.0
Protease	1.0	1.0	1.0

WO 97/43391

PCT/US97/08442

65

Lipase		0.4	0.4	0.4
Amylase		0.6	0.6	0.6
Cellulase		0.6	0.6	0.6
Silicone antifoam		5.0	5.0	5.0
Dry additives				
Sodium sulfate		0.0	3.0	0.0
Balance (Moisture & Miscellaneous)	To:	100.0	100.0	100.0
Density (g/litre)		850	850	850

\*The AQA-1 (CocoMeEO2) surfactant of the Example may be replaced by an equivalent amount of any of surfactants AQA-2 through AQA-22 or other AQA surfactants herein.

#### EXAMPLE IV

The following high density detergent formulations according to the present invention are prepared:

	<u>M</u>	<u>N</u>
Blown Powder		
Zeolite A	2.5	2.5
Sodium sulfate	1.0	1.0
CocoMeEO2*	1.5	1.5
Agglomerate		
C45AS	11.0	14.0
Zeolite A	15.0	6.0
Carbonate	4.0	8.0
MA/AA	4.0	2.0
CMC	0.5	0.5
DTPMP	0.4	0.4
Spray On		
C25E5	5.0	5.0
Perfume	0.5	0.5
Dry Adds		
HEDP	0.5	0.3
SKS 6	13.0	10.0

66

Citrate	3.0	1.0
TAED	5.0	7.0
Percarbonate	15.0	15.0
Mn Catalyst	0.03	1.4
SRA 1	0.3	0.3
Protease	1.4	1.4
Lipase	0.4	0.4
Cellulase	0.6	0.6
Amylase	0.6	0.6
Silicone antifoam	5.0	5.0
Brightener 1	0.2	0.2
Brightener 2	0.2	-
Balance (Moisture & Miscellaneous)	To: 100	100
Density (g/litre)	850	850

\*The AQA-1 (CocoMeEO<sub>2</sub>) surfactant of the Example may be replaced by an equivalent amount of any of surfactants AQA-2 through AQA-22 or other AQA surfactants herein.

Any of the granular detergent compositions provided herein may be tabletted using known tableting methods to provide detergent tablets.

Modern automatic dishwashing detergents can contain bleaching agents such as hypochlorite sources; perborate, percarbonate or persulfate bleaches; enzymes such as proteases, lipases and amylases, or mixtures thereof; rinse-aids, especially nonionic surfactants; builders, including zeolite and phosphate builders; low-sudsing detergent surfactants, especially ethylene oxide/propylene oxide condensates. Such compositions are typically in the form of granules or gels.

The following Examples A and B further illustrate the invention herein with respect to a granular phosphate-containing automatic dishwashing detergent.

#### EXAMPLE V

% by weight of active material

<u>INGREDIENTS</u>	<u>A</u>	<u>B</u>
STPP (anhydrous) <sup>1</sup>	31	26

Sodium Carbonate	22	32
Silicate (% SiO <sub>2</sub> )	9	7
Surfactant (nonionic)	3	1.5
NaDCC Bleach <sup>2</sup>	2	--
AQA-1*	0.5	1.0
Sodium Perborate	7.79	5
TAED	--	1.5
Co Catalyst	0.2	0.2
Savinase (Au/g)	--	0.04
Termamyl (Amu/g)		425
Sulfate	<u>25</u>	<u>25</u>
Perfume/Minors	to 100%	to 100%

<sup>1</sup>Sodium tripolyphosphate

<sup>2</sup>Sodium dichlorocyanurate

\*The bis-AQA-1 surfactant can be replaced by bis-AQA-2 through bis-AQA-22.

#### EXAMPLE VI

The following illustrates mixtures of AQA surfactants which can be substituted for the AQA surfactants listed in any of the foregoing Examples. As disclosed hereinabove, such mixtures can be used to provide a spectrum of performance benefits and/or to provide cleaning compositions which are useful over a wide variety of usage conditions. Preferably, the AQA surfactants in such mixtures differ by at least 1.5, preferably 2.5-20, total EO units. Ratio ranges (wt.) for such mixtures are typically 10:1-1:10. Non-limiting examples of such mixtures are as follows.

<u>Components</u>	<u>Ratio (wt.)</u>
AQA-1 + AQA-5	1:1
AQA-1 + AQA-10	1:1
AQA-1 + AQA-15	1:2
AQA-1 + AQA-5 + AQA-20	1:1:1
AQA-2 + AQA-5	3:1
AQA-5 + AQA-15	1.5:1
AQA-1 + AQA-20	1:3

Mixtures of the AQA surfactants herein with the corresponding cationic surfactants which contain only a single ethoxylated chain can also be used. Thus, for example, mixtures of ethoxylated cationic surfactants of the formula  $R^1N^+CH_3[EO]_x[EO]_yX^-$  and  $R^1N^+(CH_3)_2[EO]_zX^-$ , wherein  $R^1$  and  $X$  are as disclosed above and wherein one of the cationics has  $(x+y)$  or  $z$  in the range 1-5 preferably 1-2 and the other has  $(x+y)$  or  $z$  in the range 3-100, preferably 10-20, most preferably 14-16, can be used herein. Such compositions advantageously provide improved detergency performance (especially in a fabric laundering context) over a broader range of water hardness than do the cationic surfactants herein used individually. It has now been discovered that shorter EO cationics (e.g., EO2) improve the cleaning performance of anionic surfactants in soft water, whereas higher EO cationics (e.g., EO15) act to improve hardness tolerance of anionic surfactants, thereby improving the cleaning performance of anionic surfactants in hard water. Conventional wisdom in the detergency art suggests that builders can optimize the performance "window" of anionic surfactants. Until now, however, broadening the window to encompass essentially all conditions of water hardness has been impossible to achieve.

#### EXAMPLE VII

The following illustrates mixtures of conventional non-AQA surfactants which can be used in combination with the AQA surfactants in any of the foregoing Examples, but is not intended to be limiting thereof. The ratios of non-AQA surfactants in the mixtures are noted in parts by weight of the surfactant mixtures.

#### Mixtures A-C

<u>Ingredients</u>	<u>Ratios</u>
AS*/LAS	1:1
AS/LAS	10:1 (pref. 4:1)
AS/LAS	1:10 (pref. 1:4)

\*In the foregoing, the primary, substantially linear AS surfactant can be replaced by an equivalent amount of secondary AS or branched-chain AS, oleyl sulfate, and/or mixtures thereof, including mixtures with linear, primary AS as shown above. The "tallow" chain length AS is particularly useful under hot water conditions, up to the boil. "Coconut" AS is preferred for cooler wash temperatures.

The mixtures of alkyl sulfate/anionic surfactants noted above are modified by incorporating a nonionic non-AQA surfactant therein at a weight ratio of anionic (total) to nonionic in the range of 25:1 to 1:5. The nonionic surfactant can comprise any of

the conventional classes of ethoxylated alcohols or alkyl phenols, alkylpolyglycosides or polyhydroxy fatty acid amides (less preferred if LAS is present), or mixtures thereof, such as those disclosed hereinabove.

#### Mixtures D-F

AS*/AES	1:1
AS/AES	10:1 (pref. 4:1)
AS/AES	1:10 (pref. 1:4)

\*Can be replaced by secondary, branched or oleyl AS as noted above.

The mixtures of AS/AES noted above can be modified by incorporating LAS therein at a weight ratio of AS/AES (total) to LAS in the range from 1:10 to 10:1.

The mixtures of AS/AES or their resulting AS/AES/LAS mixtures can also be combined with nonionic surfactants as noted for Mixtures A-C at weight ratios of anionic (total) to nonionic in the range of 25:1 to 1:5.

Any of the foregoing mixtures can be modified by the incorporation therein of an amine oxide surfactant, wherein the amine oxide comprises from 1% to 50% of the total surfactant mixture.

Highly preferred combinations of the foregoing non-AQA surfactants will comprise from 3% to 60%, by weight, of the total finished laundry detergent composition. The finished compositions will preferably comprise from 0.25% to 3.5%, by weight, of the AQA surfactant.

#### EXAMPLE VIII

This Example illustrates perfume formulations (A-C) made in accordance with the invention for incorporation into any of the foregoing Examples of bis-AQA-containing detergent compositions. The various ingredients and levels are set forth below.

<u>Perfume Ingredient</u>	<u>(% Weight)</u>		
	<u>A</u>	<u>B</u>	<u>C</u>
Hexyl cinnamic aldehyde	10.0	-	5.0
2-methyl-3-(para-tert-butylphenyl)-propionaldehyde	5.0	5.0	-
7-acetyl-1,2,3,4,5,6,7,8-octahydro-1,1,6,7-tetramethyl naphthalene	5.0	10.0	10.0
Benzyl salicylate	5.0	-	-
7-acetyl-1,1,3,4,4,6-hexamethyltetralin	10.0	5.0	10.0
Para-(tert-butyl) cyclohexyl acetate	5.0	5.0	-
Methyl dihydro jasmonate	-	5.0	-
Beta-naphthol methyl ether	-	0.5	-
Methyl beta-naphthyl ketone	-	0.5	-
2-methyl-2-(para-iso-propylphenyl)-propionaldehyde	-	2.0	-
1,3,4,6,7,8-hexahydro-4,6,6,7,8,8-hexamethyl-cyclopenta-gamma-2-benzopyrane	-	9.5	-
Dodecahydro-3a,6,6,9a-tetramethylnaphtho-[2,1b]furan	-	-	0.1
Anisaldehyde	-	-	0.5
Coumarin	-	-	5.0
Cedrol	-	-	0.5
Vanillin	-	-	5.0
Cyclopentadecanolide	3.0	-	10.0
Tricyclodecenyl acetate	-	-	2.0
Labdanum resin	-	-	2.0
Tricyclodecenyl propionate	-	-	2.0
Phenyl ethyl alcohol	20.0	10.0	27.9
Terpineol	10.0	5.0	-
Linalool	10.0	10.0	5.0
Linalyl acetate	5.0	-	5.0
Geraniol	5.0	-	-
Nerol	-	5.0	-
2-(1,1-dimethylethyl)-cyclohexanol acetate	5.0	-	-
Orange oil, cold pressed	-	5.0	-
Benzyl acetate	2.0	2.0	-
Orange terpenes	-	10.0	-
Eugenol	-	1.0	-

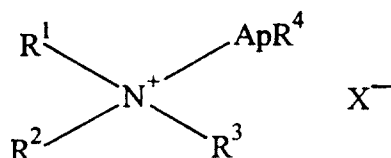


Diethylphthalate	-	9.5	-
Lemon oil, cold pressed	-	-	<u>10.0</u>
Total	100.0	100.0	100.0

The foregoing perfume compositions are admixed or sprayed-onto (typically at levels up to about 2% by weight of the total detergent composition) any of the AQA surfactant-containing cleaning (including bleaching) compositions disclosed herein. Improved deposition and/or retention of the perfume or individual components thereof on the surface being cleaned (or bleached) is thus secured.

WHAT IS CLAIMED IS:

1. A detergent composition comprising or prepared by combining a peroxygen bleach, a bleach catalyst, a non-AQA surfactant and an effective amount of an alkoxyated quaternary ammonium (AQA) cationic surfactant of the formula:



wherein R<sup>1</sup> is a linear, branched or substituted C<sub>8</sub>-C<sub>18</sub> alkyl, alkenyl, aryl, alkaryl, ether or glyceryl ether moiety, R<sup>2</sup> is a C<sub>1</sub>-C<sub>3</sub> alkyl moiety, R<sup>3</sup> and R<sup>4</sup> can vary independently and are selected from hydrogen, methyl and ethyl, X is an anion, A is C<sub>1</sub>-C<sub>4</sub> alkoxy and p is an integer in the range of from 2 to 30.

2. A composition according to Claim 1 wherein the peroxygen bleach is selected from the group consisting of perborate, percarbonate, perphosphate, persilicate or persulfate salts or a preformed peracid.
3. A composition according to either of Claims 1 or 2 wherein the bleach catalyst is a manganese or a cobalt-containing bleach catalyst.
4. A composition according to any of Claims 1 to 3 which is prepared by mixing the non-AQA surfactant and the AQA surfactant.
5. A composition according to any of Claims 1 to 4 wherein the non-AQA surfactant is an anionic surfactant.
6. A composition according to any of Claims 1 to 5 wherein the ratio of AQA to non-AQA surfactant is from 1:15 to 1:8.
7. A composition according to any of Claims 1 to 6 wherein, said AQA surfactant has the formula R<sup>1</sup> is C<sub>8</sub>-C<sub>18</sub> alkyl, R<sup>2</sup> is methyl A is an ethoxy or propoxy groups and p is an integer of from 2 to 8.
8. A composition according to any of Claims 1 to 7 wherein, the AQA surfactant has the formula R<sup>1</sup> is C<sub>8</sub>-C<sub>18</sub> alkyl, R<sup>2</sup> is methyl A is an ethoxy or propoxy groups and p is an integer of from 2 to 4.

9. A composition according to Claim 1 to 8 comprising two or more AQA surfactants, or a mixture of AQA surfactant and a mono-ethoxylated cationic surfactant.
10. A composition according to Claim 1 to 9 comprising two or more non-AQA surfactants and a mixture of two or more AQA surfactants.
11. A composition according to any of Claims 1 to 10 in a granular, bar, non-aqueous liquid, or tablet form.
12. A method for removing soils and stains by contacting said soils and stains with a detergent composition, or aqueous medium comprising said detergent composition, according to Claims 1 to 10.
13. A method according to Claim 12 to for removing body soil, bleach sensitive soil or surfactant sensitive soil from fabrics.
14. A method according to either of Claims 12 or 13 which is conducted in an automatic machine.
15. A method according to any of Claims 12 to 14 which is conducted by hand.
16. A method for enhancing the deposition or substantivity of perfumes or perfume ingredients onto fabrics or other surfaces, comprising contacting said surfaces with a perfume or perfume ingredient in the presence of an AQA surfactant.
17. A method according to Claim 18 which is conducted using a perfume or perfume ingredient in combination with a detergent composition comprising a AQA.