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(54) **Title:** LAUNDRY COMPOSITION

(57) **Abstract:** The present invention relates to a solid unit dose laundry composition. The laundry detergent composition includes LAS obtained from waste plastic feedstock without any undue effect on the performance of the composition.

LAUNDRY COMPOSITION

Field of the Invention

The present invention relates to a laundry detergent composition. In particular, a laundry composition having an improved surfactant.

Background of the Invention

Surfactants are the main cleaning ingredient in a laundry composition. The synthetic surfactant currently used in laundry detergent composition are predominantly derived from petroleum feedstock.

The synthesis of the surfactant linear alkyl benzene sulphonate (LAS) is described in Anionic Surfactants: Organic Chemistry (Surfactant Science Series Vol 56 edited by H. Stache), Marcel Dekker 1995. The chemistry involves production of linear C10/13 olefins which are reacted with benzene to form linear alkyl benzene (LAB) and then sulphonated to give LAS. The olefins can be obtained from CO via *Fischer Tropsch* synthesis, but today are derived from petroleum.

The LAS produced is a complex mix of compounds with varying chain length and isomers. The properties of LAS are determined by the composition of the mixture. This is particularly key when used in laundry composition, as small changes in the composition of LAS may influence factors such as the processing of the laundry composition, storage stability, and performance of other ingredients in the composition.

Modern society relies on plastic for a wide range of products, including the packaging of laundry detergent compositions. The recycling of plastic waste is a key issue.

Many plastics cannot be recycled by mechanical means, an alternative is chemical recycling. In chemical recycling the plastic is pyrolyzed to produce pyrolysis oil, a complex mixture of aromatics, alkanes, cycloalkanes, alkenes, cycloalkenes and oxygenates. An illustration of a typical product mix from pyrolysis oil is described in “Chemical recycling of plastic waste: Bitumen, solvents and polystyrene from pyrolysis oil” in *Waste Management* 118 (2020) 139-147 by Baene-Gonzalez *et al.* Agricultural and waste products, such as oils, plant shells and husks may also be used to make pyrolysis oil. Once produced pyrolysis oil may be distilled to give the necessary raw materials to make LAS. It is desired to provide LAS from the plastic waste feedstock which is similar to the current LAS obtained from the petroleum feedstock.

WO 2017/027271 (P&G) discloses methods for producing detergent compounds from waste plastic feedstocks. More specifically, the invention relates to methods for producing detergent intermediates, including alkylbenzenes, paraffins, olefins, oxo alcohols, and surfactant derivatives thereof from waste plastic feedstock.

WO2020/178597 (Oxford Sustainable Fuels Ltd) discloses a process for upgrading a pyrolysis oil derived from plastic or rubber.

There is a need for a way to incorporate pyrolysis-based LAS obtained from waste plastic feedstock into laundry detergent composition without dramatically changing the detergent's properties. There is a need for a way to incorporate pyrolysis-based LAS obtained from waste plastic feedstock into laundry composition without dramatically changing the detergent's properties. Preferably the amount of pyrolysis-based LAS obtained from waste plastic feedstock is such that it compensates for the plastic packing used to transport the detergent composition, by a factor of greater than 1, more preferably great than 10, most preferably greater than 100 times.

LAB is typically manufactured using petroleum feedstocks on a large scale by the petroleum industry. LAB is converted to LAS by smaller industrial plants before being incorporated as LAS acid in detergent compositions. In the composition the LAS acid is neutralized by a counterions with alkali metal salts or ammoniacal salts.

The key to LAS's success in detergent composition is that it is a varied mixture of components. Variety resides in the number of carbon atoms in the alkyl chain as well as the point in the alkyl chain that the alkyl chain is linked to the benzene ring. There also exist isomers of LAS for example the 2-phenyl isomer which appears relevant to the overall performance of LAS in use.

The variety of materials present in a LAS batch also figures in the supply chain. The LAS, (or more correctly LAB) produced is influenced by the feedstock. Different petroleum feedstocks will produce different LAB mixtures. In the consumer products industry this is managed with reference to a specification which covers a range of LAB characteristics. The specification is designed to ensure that no matter the actual nature of any one sample, that it is able to function as required in a detergent formulation.

Functioning in a detergent formulation, in particular a laundry composition is also important, not just for the detergency benefit provided by the LAS but the influence on the performance of other ingredients present in the laundry detergent composition.

The performance of other components typically present in the laundry composition such as perfume, other surfactants, fluorescers and enzymes are heavily influenced by the nature of LAS and the specification is designed to ensure that these materials are not unduly affected by the varying nature of the LAS.

For this reason, the incorporation of different feedstocks into the supply chain, while desirable, has huge consequences on the performance of LAS and the other materials commonly found in laundry compositions.

Accordingly, a need still exists for laundry detergent composition having LAS obtained from plastic waste feedstock which provides good detergency performance while not adversely affecting the other components of the laundry detergent composition.

It is thus an object of the present invention to provide a laundry composition comprising a LAS obtained from plastic waste feedstock.

It is yet another object of the present invention to provide a laundry composition comprising a LAS obtained from plastic waste feedstock which has good in wash performance.

Summary of the Invention

We have surprisingly found that the use of waste plastic feedstock in LAB production needs careful management before being able to provide a viable LAB raw material for detergent composition.

We have surprisingly found that when LAS obtained from waste plastic feedstock is incorporated into a laundry composition along with specific enzyme, the LAS obtained from waste plastic feedstock can be incorporated into the composition without any undue effect on the performance of the laundry composition. In particular, the composition remains storage stable, and the performance of the enzyme in the composition is maintained or even improved when the amount of waste plastic feedstock-based LAS described herein are provided within certain levels. It was also found that the LAS obtained from waste plastic feedstock has a higher wetting ability as compared to the petroleum derived feedstock which provides the LAS obtained from waste plastic feedstock with better ability to remove stains and has better cleaning performance. The present inventors have found that in a laundry composition, the enzyme has better access to the stains in presence the combination of LAS obtained from waste plastic feedstock and LAS obtained from petroleum feedstock and shows improved cleaning performance.

According to a first aspect of the present invention disclosed is a laundry composition including linear alkyl benzene sulphonate (LAS) obtained from waste plastic feedstock, LAS obtained from petroleum feedstock and an enzyme.

According to a second aspect of the present invention disclosed is a method of preparing a laundry composition according to the first aspect, the method comprising the steps of:

i) obtaining a LAS surfactant from a plastic waste feedstock, preferably from pyrolysis oil prepared from the plastic waste; and,

ii) incorporating the LAS surfactant obtained from a plastic waste feedstock, LAS obtained from petroleum and an enzyme into a laundry composition.

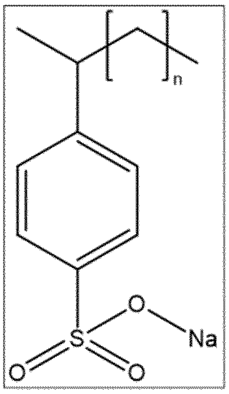
According to a third aspect of the present invention disclosed is a use a LAS obtained from a plastic waste feedstock, LAS obtained from petroleum feedstock and an enzyme in a laundry composition according to the first or second aspect of the present invention to lower the amount of the ingredients in the laundry composition derived from a petroleum feedstock as compared to a traditional laundry composition.

Detailed Description of the Invention

According to a first aspect of the present invention disclosed is a laundry composition including linear alkyl benzene sulphonate (LAS) obtained from waste plastic feedstock, LAS obtained from petroleum feedstock and an enzyme.

LAS obtained from waste plastic feedstock

According to the first aspect the laundry composition includes a LAS obtained from waste plastic feedstock. Preferably the LAS from the pyrolysis of waste plastic feedstock is made via an alkylation reaction of benzene with an n-olefin, then sulphonation. Preferably alkyl chains obtained from the pyrolysis oil and used to make the LAS has a distillation range of 174°C to 220°C.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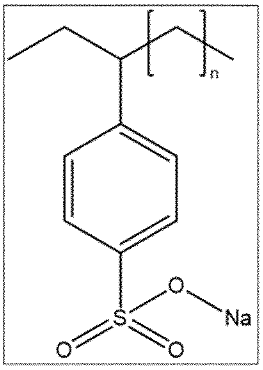

(B)

Preferably, the weight ratio of (A):(B) is from 2:1 to 1:2, more preferably from 3:2 to 1:2, most preferably 5:4 to 4:5 in the LAS obtained from plastic waste feedstock. Preferably these two isomers represent from 20 wt.% to 70 wt.% of the LAS obtained from plastic waste feedstock, more preferably from 30 wt.% to 40 wt.%. Preferably the LAS obtained from waste plastic feedstock includes at least 15 wt.% 2-phenyl isomer, more preferably at least 20 wt.%. Still preferably 2-phenyl isomer is present in an amount ranging from 1 wt.% to 30 wt.% by weight of the LAS obtained from waste plastic feedstock. In the above-mentioned structure, the Na counterion may also be replaced by any other counterion known to a person skilled in the art.

During the addition reaction of the alkyl chain to the benzene ring in the production of LAS, non-benzene aromatics-based side products may be produced, for example addition of the alkyl chain to styrene or addition of styrene to benzene. Toluene based products are another example. Preferably LAS adducts with non-benzene aromatics are less than 2 wt.% of the LAS obtainable from waste-plastic feedstock, pyrolysis LAS. Preferably LAS adducts with styrene are less than 1 wt.% of the LAS obtainable from waste-plastic feedstock, the pyrolysis LAS. Styrene monomers may be removed from pyrolysis oil by for example distillation or polymerization and extraction.

In a preferred embodiment the benzene required for LAS synthesis is obtained from pyrolysis oil obtained from the waste plastic feedstock and the alkyl chain of LAS is obtained from a biobased source, preferably plant source. The alkyl chain can be obtained from plant oils by metathesis reactions as described in Angewandte Chemie International Edition; 51 (2012), 24. - S. 5802-5808 by Samir Chikkali and Stefan Mecking. The feedstock for the metathesis reaction of the invention includes but is not limited to fatty acids, fatty esters, fats, oils for the formation of mixtures of C_{10} to C_{14} alkenes. Preferably the fatty acid, fatty ester, fat, and/or oil has an iodine value of at least about 15, preferably at least about 50, more preferably at least about 180. The iodine value, which can be determined using the AOAC Official Method of Analysis (1984), Chapter 28.023, is the mass of iodine in grams that is consumed by 100 grams of a chemical substance (see, e.g., Pocklington, Pure & Appl. Chem. 62(12):2339-2343 (1990)). Further, the fatty acid, fatty ester, fat, and/or oil comprises at least about 10 wt.%, preferably at least about 20 wt.% of fatty acids, fatty esters, fats, and/oils that have at least 10 carbon atoms, based on the total weight of the fatty acids, fatty esters, fats, and/or oils.

The alkyl group on the linear alkylbenzene sulfonates each independently have a total of 10, 11, 12, 13, or 14 carbon atoms. Preferably, the LAS obtained from waste plastic feedstock comprises alkyl chains with an average chain length from 8 to 14 carbons, preferably 10 to 14 carbons, more preferably from 10 to 13 and most preferably from 11 to 12. Preferably, at least 30 wt.% of the LAS obtained from waste plastic feedstock comprises alkyl chains with 12 carbons. Preferably, at least 30 wt.% of the LAS obtained from waste plastic feedstock comprises alkyl chains with 11 carbons. Preferably less than 5 wt.% of linear alkylbenzene sulfonates obtained from the plastic waste feedstock have alkyl groups with 9 or fewer carbon atoms and alkyl groups that have 15 or more carbon atoms. Preferably the LAS obtained from waste plastic feedstock comprises a benzene moiety obtained from waste plastic feedstock and an olefin group obtained from a petroleum feedstock. Preferably the LAS obtained from waste plastic feedstock comprises a benzene moiety obtained from waste plastic feedstock and an alkyl group obtained from a plant-based feedstock. Preferably the LAS obtained from waste plastic feedstock comprises a benzene moiety obtained from waste plastic feedstock and an alkyl group obtained from waste plastic feedstock.

The alkyl chain can be attached to any position on the benzene ring. The sulphonate group includes a cation M which may be hydrogen or a metal ion, such as an alkali metal (e.g., sodium, lithium, potassium), an alkaline earth metal (e.g., calcium, magnesium), or the like.

The alkyl group on the linear alkylbenzene sulfonates may include a biobased content, preferably plant source, of at least about 5%, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 95%, for example about 100%.

Preferably, the laundry composition comprises from 1 wt.% to 40 wt.% LAS, more preferably from 2 to 20% wt. LAS. Preferably the laundry composition comprises at least 4 wt.%, still preferably at least 5 wt.%, still preferably at least 10 wt.%, most preferably at least 15 wt.% of LAS, but typically not more than 45 wt.%, still preferably not more than 40 wt.%, still further preferably not more than 35 wt.%, still more preferably not more than 30 wt.% and most preferably not more than 25 wt.%, still more preferably not more than 20 wt.% of LAS based on the weight of the detergent composition.

Preferably, the LAS obtained from waste plastic feedstock comprises from 0.001 wt.% to 20 wt.%, still preferably 0.001 wt.% to 8 wt.%, preferably from 1 wt.% to 8 wt.% of the total LAS present in the composition.

The remaining LAS is from petroleum feedstock or preferably selected from those obtained from a combination of petroleum and other sources, preferably petroleum feedstock. Laundry composition having these levels of LAS obtained from waste plastic feedstock maintain similar processing conditions and performance as traditional composition, whereas moving beyond these levels, a change in the processing or formulation of composition may be required. Preferably the LAS includes an alkyl component obtained from a renewable source, more preferably from a plant, algae or yeast.

Preferably the level of tetralins is less than 8 wt.%, more preferably less than 0.5 wt.%, still preferably less than 0.1 wt.% in the laundry composition. Preferably the level of isoalkylbenzenes is less than 6 wt.% more preferably less than 1 wt.% in the laundry composition. Preferably, the 2-phenyl isomer content is at least 10 wt%. of the total LAS, more preferably at least 15 wt.% and most preferably at least 20 wt.% wt. of the total LAS present in the composition.

Enzyme

The laundry composition according to the first aspect of the present invention includes an enzyme. The enzyme is preferably a detersive enzyme. "Detersive enzyme", as used herein, means any enzyme having a cleaning, stain removing, fabric caring or otherwise beneficial effect in laundry composition.

Enzymes are normally incorporated into laundry compositions at levels sufficient to provide a "cleaning-effective amount". The term "cleaning effective amount" refers to any amount sufficient to provide an in-wash effect, the effect including but not limited to producing a cleaning, stain removal, soil removal, whitening, deodorizing, fabric caring or freshness improving effect on textile.

Preferred detersive enzyme is selected from the group consisting proteases, amylases, lipases, cellulases, endoglucanases, hemicellulases, peroxidases, proteases, gluco-amylases, amylases, cutinases, pectinases, xylanases, reductases, oxidases, phenoloxidases, lipoxygenases, ligninases, pullulanases, tannases, pentosanases, malanases, β-glucanases, arabinosidases, mannanases, xyloglucanases or mixtures thereof. Preferably the laundry composition has a cocktail of conventional applicable enzymes like protease, amylase, lipase, cutinase, mannanases, xyloglucanases and/or cellulase. More preferably enzyme cocktail having a combination of protease, amylase, lipase, mannanase, cellulase or combinations thereof. Enzymes when present in the compositions, at from about 0.0001 % to about 5% of active enzyme by weight.

In one aspect, the compositions and methods of the present invention may include a protease enzyme from about 0.0001% to about 5%, specifically from about 0.001% to about 2%, more specifically from about 0.001% to about 1%, even more specifically from about 0.001% to about 0.2%, even more specifically still from about 0.005% to about 0.1%, by weight of a protease enzyme. Any protease suitable for use in detergents can be used. Such proteases can be of animal, vegetable or microbial origin, with both modified (chemical or genetically variants) and unmodified proteases included.

One class of suitable proteases include the so-called serine endopeptidases [E.C. 3.4.21] and an example of which are the serine protease [E.C. 3.4.21.62]. Illustrative non-limiting examples of serine proteases includes subtilisins, e.g. subtilisins derived from Bacillus (e.g. B. subtilis, B. lentus, B. licheniformis, B. amyloliquefaciens, B. alcalophilus), for example, subtilisins BPN and BPN', subtilisin Carlsberg, subtilisin 309, subtilisin 147, subtilisin 168, subtilisin PB92, their mutants and mixtures thereof.

Illustrative non-limiting examples of commercially available serine proteases, include, Alcalase®, Savinase®, Kannase®, Iwerlase® available from Novozymes; Purafect®, Purastar OxAm®, Properase® available from Genencor; BLAP and BLAP variants available from Henkel; and K-16 - like proteases available from KAO. Additional illustrative proteases are described in e.g. EP130756, WO91/06637, WO95/10591, WO99/20726, US 5030378 (Protease "A") and EP251446 (Protease "B").

Examples of commercially available lipases include Lipex™, Lipoprime™ Lipolase™, Lipolase™ Ultra, Lipozyme™, Palatase™, Novozym™ 435 and Lecitase™ (all available from Novozymes A/S). [0023] Other commercially available lipases include Lumafast™ (Pseudomonas mendocina lipase from Genencor International Inc.); Lipomax™ (Ps. pseudoalcaligenes lipase from Genencor

Int. Inc); and Bacillus sp. lipase from Genencor International Inc. Further lipases are available from other suppliers.

Examples of commercial α-amylases products are Purafect Ox Am® from Genencor and Termamyl®, Termamyl Ultra® Ban® ,Fungamyl® and Duramyl®, all available from Novo Nordisk A/S Denmark. WO95/26397 describes other suitable amylases : α-amylases characterised by having a specific activity at least 25% higher than the specific activity of Termamyl® 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® α-amylase activity assay. Suitable are variants of the above enzymes, described in WO96/23873 (Novo Nordisk). Other amylolytic enzymes with improved properties with respect to the activity level and the combination of thermostability and a higher activity level are described in WO95/35382.

The compositions of the present invention may also comprise a mannanase enzyme. The mannanase can be selected from the group consisting of: three mannans-degrading enzymes : EC 3.2.1.25 : β-mannosidase, EC 3.2.1.78 : Endo-1,4-β-mannosidase, referred therein after as "mannanase" and EC 3.2.1.100 : 1,4-β-mannobiosidase and mixtures thereof. (IUPAC Classification- Enzyme nomenclature, 1992 ISBN 0-12-227165-3 Academic Press). Alternatively, the compositions of the present invention, when a mannanase is present, comprise a β-1,4-Mannosidase (E.C. 3.2.1.78) referred to as Mannanase. The term "mannanase" or "galactomannanase" denotes a mannanase enzyme defined according to the art as officially being named mannan endo-1,4-beta-mannosidase and having the alternative names beta-mannanase and endo-1,4-mannanase and catalysing the reaction: random hydrolysis of 1,4-beta-D-mannosidic linkages in mannans, galactomannans, glucomannans, and galactoglucomannans. Mannanases (EC 3.2.1.78) constitute a group of polysaccharases which degrade mannans and denote enzymes which are capable of cleaving polyose chains contaning mannose units, i.e. are capable of cleaving glycosidic bonds in mannans, glucomannans, galactomannans and galactogluco-mannans. Mannans are polysaccharides having a backbone composed of β-1,4-linked mannose; glucomannans are polysaccharides having a backbone or more or less regularly alternating β-1,4 linked mannose and glucose; galactomannans and galactoglucomannans are mannans and glucomannans with α-1,6 linked galactose side branches. These compounds may be acetylated.

Known cellulases include endoglucanase (E.C.3.2.1.4) enzyme produced by Bacillus sp. AA349 such as CELLUCLEAN® as well as CELLUZYME from Novozymes. Additional cellulase enzymes suitable for use in the present invention include those disclosed in WO Publ. 2004/053039A2, WO Publ. 2002/099091A2, U.S. 2004/0002431A1, U.S. 4,945,053, and U.S. 4,978,470. Additional endoglucanase enzymes which can be used in accordance with the present invention include xyloglucanases such as disclosed in WO0162903A1 to Novozymes.

Preferably the amount of detersive enzyme present in a laundry composition ranges from 0.001 wt.% to 5 wt.% by weight of the composition. Typical amounts are in the range from 0.01 wt.% to 1 wt.% by weight of the laundry composition.

Preferably the enzymes may be present in the form of a granule having one or more enzymes. It is also preferred that the enzyme is in the form of a granule having one or more enzymes where the granule has a core and a shell structure.

Enzyme stabilizers:
Preferably the composition includes an enzyme stabilizer. Illustrative examples of enzyme stabilizers include any known stabilizer system like calcium and/or magnesium compounds, low molecular weight carboxylates, relatively hydrophobic organic compounds (i.e., certain esters, dialkyl glycol ethers, alcohols or alcohol alkoxylates), alkyl ether carboxylate in addition to a calcium ion source, benzamidine hypochlorite, lower aliphatic alcohols and carboxylic acids, N,N-bis(carboxymethyl) serine salts; (meth)acrylic acid-(meth)acrylic acid ester copolymer and PEG; lignin compounds, polyamide oligomer, glycolic acid or its salts; polyhexa methylene bi guanide or N,N-bis-3-amino-propyl-dodecyl amine or salt; and mixtures thereof. See also U.S. Pat. No. 3,600,319, Gedge, et al., EP 0 199 405 A, Venegas, U.S. Pat. No. 3,519,570 and reversible peptide protease inhibitor.

LAS obtained from petroleum feedstock

The laundry detergent composition includes a LAS obtained from petroleum feedstock. The LAS obtained from petroleum feedstock is well known to a person skilled in the art and is used in the traditional laundry detergent composition. By LAS obtained from petroleum feedstock it is meant that the LAS is obtained directly from the petroleum supply chain and relates to the industry standard LAS. This excludes LAS which is processed from waste-plastic which involves extracting material from waste products, processing them to form the materials which are fed back into the feedstock to produce LAS. It is acknowledged that literally, waste-plastic feedstock is also ultimately derived from the petroleum supply chain, but has an extra stage in its processing relating its constituent parts being used in different raw materials in a different context, e.g. as packaging materials. It is this extra stage which distinguishes it from what a LAS obtained from petroleum feedstock.

The term LAB and LAS are often used interchangeably. LAB is the material commercially handles whereas the sulphonation step to turn LAB into LAS occurs at the end is often carried out by the end user. Further, in liquid formulations the LAS is neutralised in situ and the weight proportions described herein refer to the protonated form.

Examples of commercially available LAS obtained from petroleum feedstock includes those from Galaxy surfactants.

The alkyl group on the LAS obtained from petroleum feedstock may each independently have a total of 10, 11, 12, 13, or 14 carbon atoms. Preferably, the LAS obtained from petroleum feedstock comprises alkyl chains with an average chain length from 8 to 14 carbons, more preferably from 10 to 13 and most preferably from 11 to 12. Preferably, at least 30 wt.% of the LAS obtained from petroleum feedstock comprises alkyl chains with 12 carbons. Preferably, at least 30 wt.% of the LAS obtained from petroleum feedstock comprises alkyl chains with 11 carbons. Preferably less than 5 wt.% of linear alkylbenzene sulfonates obtained from the petroleum feedstock have alkyl groups with 9 or fewer carbon atoms and alkyl groups that have 15 or more carbon atoms.

Preferably, the alkyl chain comprises a mixture of chain lengths but has an average of from 8 to 16, more preferably from 10 to 14 and most preferably from 11 to 12. Alkyl chain length with an average from 11.5 to 11.7 is a particularly preferred range. Preferably the LAS contains more than 80 wt% of the C_{10}, C_{11}, C_{12} and C_{13} alkyl chains. Preferably the weight ratio of C_{10}:C_{11} is from 1:2 to 1:5. Preferably the weight ratio of C_{10}:C_{12} is from 1:2 to 1:5. Preferably the weight ratio of C_{10}:C_{13} is from 1:1 to 1:3.

The alkyl chain can be attached to any position on the benzene ring. The sulphonate group includes a cation M which may be hydrogen or a metal ion, such as an alkali metal (e.g., sodium, lithium, potassium), an alkaline earth metal (e.g., calcium, magnesium), or the like.

The term "linear" as used herein, with respect to LAB and/or LAS, indicates that the alkyl portions thereof contain less than 30%, preferably less than 20%, more preferably less than 10% branched alkyl chains.

Typically, LAB and the corresponding LAS obtained from petroleum feedstock contains a distribution of isomers in which the benzene moiety is attached in various positions on the hydrophobic alkyl chain. It is the hydrophobic portion of LAS which attaches to soil. A typical LAB obtained from petroleum feedstock used to form LAS contains a distribution of various LAB isomers, such as 2-phenyl LAB, 3-phenyl LAB, 4-phenyl LAB, etc. Preferably, the weight ratio of structure with formula (A): formula (B) as given above is from 2:1 to 1:2, more preferably from 3:2 to 1:2, most preferably 5:4 to 4:5 in the LAS obtained from petroleum feedstock. Preferably these two isomers represent from 20 wt.% to 70 wt.% of the LAS obtained from petroleum feedstock, more preferably from 30 wt.% to 40 wt.%. Preferably 2-phenyl isomer is present in an amount ranging from 1 wt.% to 30 wt.% by weight of the LAS obtained from petroleum. In the above-mentioned structure, the Na counterion may also be replaced by any other counterion known to a person skilled in the art.

Laundry composition

In addition to the LAS obtainable from the plastic waste feedstock , LAS obtainable from the petroleum feedstock and enzyme, the laundry composition may additionally include one or more of the ingredients provided herein. The laundry composition according to the present invention is preferably a solid laundry composition, a liquid laundry composition or a unit dose laundry composition. Preferably the linear alkyl benzene sulphonate comprises from 50 wt.% to 100 wt.% of the total surfactant content present in the composition. Preferably the laundry composition has a pH ranging from 5 to 13, more preferably 6 to 11, still preferably 6 to 8, most preferably 6.1 to 7.0. Preferably the laundry composition includes a fragrance preferably ranging from 0.5 to 3% wt. of the composition.

Liquid laundry composition:

The term “laundry detergent” in the context of this invention denotes formulated compositions intended for and capable of wetting and cleaning domestic laundry such as clothing, linens and other household textiles.

The term “linen” is often used to describe certain types of laundry items including bed sheets, pillow cases, towels, tablecloths, table napkins and uniforms. Textiles can include woven fabrics, non-woven fabrics, and knitted fabrics; and can include natural or synthetic fibres such as silk fibres, linen fibres, cotton fibres, polyester fibres, polyamide fibres such as nylon, acrylic fibres, acetate fibres, and blends thereof including cotton and polyester blends.

Examples of liquid laundry detergents include heavy-duty liquid laundry detergents for use in the wash cycle of automatic washing machines, as well as liquid fine wash and liquid colour care detergents such as those suitable for washing delicate garments (e.g. those made of silk or wool) either by hand or in the wash cycle of automatic washing machines.

The term “liquid” in the context of this invention denotes that a continuous phase or predominant part of the composition is liquid and that the composition is flowable at 15°C and above. Accordingly, the term “liquid” may encompass emulsions, suspensions, and compositions having flowable yet stiffer consistency, known as gels or pastes. The viscosity of the composition may suitably range from about 200 to about 10,000 mPa.s at 25°C at a shear rate of 21 sec^{-1}. This shear rate is the shear rate that is usually exerted on the liquid when poured from a bottle. Pourable liquid detergent compositions generally have a viscosity of from 200 to 1,500 mPa.s, preferably from 100 to 800 mPa.s.

A composition according to the invention may suitably have an aqueous continuous phase. By “aqueous continuous phase” is meant a continuous phase which has water as its basis.

A composition of the invention preferably comprises from 1 to 40%, preferably from 5 to 35%, and more preferably from 7 to 24% (by weight based on the total weight of the composition) of one or more detersive surfactants selected from non-soap anionic surfactants, nonionic surfactants and mixtures thereof.

The term “detersive surfactant” in the context of this invention denotes a surfactant which provides a detersive (i.e. cleaning) effect to laundry treated as part of a domestic laundering process.

Non-soap anionic surfactants for use in the invention are typically salts of organic sulfates and sulfonates having alkyl radicals containing from about 8 to about 22 carbon atoms, the term “alkyl” being used to include the alkyl portion of higher acyl radicals. Examples of such materials include alkyl sulfates, alkyl ether sulfates, alkaryl sulfonates, alpha-olefin sulfonates and mixtures thereof. The alkyl radicals preferably contain from 10 to 18 carbon atoms and may be unsaturated. The alkyl ether sulfates may contain from one to ten ethylene oxide or propylene oxide units per molecule, and preferably contain one to three ethylene oxide units per molecule. The counterion for anionic surfactants is generally an alkali metal such as sodium or potassium; or an ammoniacal counterion such as monoethanolamine, (MEA) diethanolamine (DEA) or triethanolamine (TEA). Mixtures of such counterions may also be employed.

Some alkyl sulfate surfactant (PAS) may be used, such as non-ethoxylated primary and secondary alkyl sulphates with an alkyl chain length of from 10 to 18.

Mixtures of any of the above-described materials may also be used.

In a composition of the invention the total level of anionic surfactant may preferably range from 20 to 90% by weight based on the total weight of the surfactant.

Also commonly used in laundry liquid compositions are alkyl ether sulfates having a straight or branched chain alkyl group having 10 to 18, more preferably 12 to 14 carbon atoms and containing an average of 1 to 3EO units per molecule. A preferred example is sodium lauryl ether sulfate (SLES) in which the predominantly C12 lauryl alkyl group has been ethoxylated with an average of 3EO units per molecule.

Preferably, the composition comprises from 20 to 95% wt. non-ionic surfactant based on the total weight of surfactant. Nonionic surfactants for use in the invention are typically polyoxyalkylene compounds, i.e. the reaction product of alkylene oxides (such as ethylene oxide or propylene oxide or mixtures thereof) with starter molecules having a hydrophobic group and a reactive hydrogen atom which is reactive with the alkylene oxide. Such starter molecules include alcohols, acids, amides or alkyl phenols. Where the starter molecule is an alcohol, the reaction product is known as an alcohol alkoxylate. The polyoxyalkylene compounds can have a variety of block and heteric (random) structures. For example, they can comprise a single block of alkylene oxide, or they can be diblock alkoxylates or triblock alkoxylates. Within the block structures, the blocks can be all ethylene oxide or all propylene oxide, or the blocks can contain a heteric mixture of alkylene oxides. Examples of such materials include C_8 to C_{22} alkyl phenol ethoxylates with an average of from 5 to 25 moles of ethylene oxide per mole of alkyl phenol; and aliphatic alcohol ethoxylates such as C_8 to C_{18} primary or secondary linear or branched alcohol ethoxylates with an average of from 2 to 40 moles of ethylene oxide per mole of alcohol.

A preferred class of nonionic surfactant for use in the invention includes aliphatic C_8 to C_{18}, more preferably C_{12} to C_{15} primary linear alcohol ethoxylates with an average of from 3 to 20, more preferably from 5 to 10 moles of ethylene oxide per mole of alcohol.

A further class of surfactants include the alkyl poly glycosides and rhamnolipids.

Mixtures of any of the above-described materials may also be used.

Preferably, the selection and amount of surfactant is such that the compositions are isotropic in nature.

LAS:

Preferably, the alkyl chain comprises a mixture of chain lengths but has an average of from 8 to 16, more preferably from 10 to 14 and most preferably from 11 to 12. 11.5 to 11.7 is a particularly preferred range. Preferably the LAS contains more than 80wt% of the C10, C11, C12 and C13 alkyl chains. Preferably the weight ratio of C10:C11 is from 1:2 to 1:5. Preferably the weight ratio of C10:C12 is from 1:2 to 1:5. Preferably the weight ratio of C10:C13 is from 1:1 to 1:3.

Preferably the level of tetralins is less than 8wt%, more preferably less than 0.5wt%.

Preferably the level of isoalkylbenzenes is less than 6wt% more preferably less than 1wt%.Preferably, the 2-phenyl isomer content is at least 10% wt. of the total LAS, more preferably at least 15% and most preferably at least 20% wt. of the LAS.

Preferred surfactants include the C18 based alkyl ether sulphates, the C18 based alcohol ethoxylates and the C18 based methyl ester ethoxylates.

C18 Alcohol Ethoxylate:

The C18 alcohol ethoxylate is of the formula:

$R_1\text{-O-}(CH_2CH_2O)_q\text{-H}$

where R_1 is selected from saturated, monounsaturated and polyunsaturated linear C18 alkyl chains and where q is from 4 to 20, preferably 5 to 14, more preferably 8 to 12. The mono-unsaturation is preferably in the 9 position of the chain, where the carbons are counted from the ethoxylate bound chain end. The double bond may be in a cis or trans configuration (oleyl or elaidyl), preferably cis. The cis or trans alcohol ethoxylate $CH_3(CH_2)_7\text{-}CH{=}CH\text{-}(CH_2)_8O\text{-}(OCH_2CH_2)_nOH$, is described as C18:1(Δ9) alcohol ethoxylate. This follows the nomenclature *CX:Y(ΔZ)* where *X* is the number of carbons in the chain, *Y* is the number of double bonds and Δ*Z* the position of the double bond on the chain where the carbons are counted from the OH bound chain end.

Preferably, R1 is selected from saturated C18 and monounsaturated C18. As regards the C18 alcohol ethoxylate content, it is preferred that the predominant C18 moiety is C18:1, more preferably C18:1(Δ9).

Alcohol ethoxylates are discussed in the Non-ionic Surfactants: Organic Chemistry edited by Nico M. van Os (Marcel Dekker 1998), Surfactant Science Series published by CRC press. Alcohol ethoxylates are commonly referred to as alkyl ethoxylates.

Linear saturated or mono-unsaturated C20 and C22 alcohol ethoxylate may also be present. Preferably the weight fraction of sum of 'C18 alcohol ethoxylate' / 'C20 and C22 alcohol ethoxylate' is greater than 10.

Preferably the C18 alcohol ethoxylate contains less than 15wt%, more preferably less than 8wt%, most preferably less than 5wt% of the alcohol ethoxylate polyunsaturated alcohol ethoxylates. A polyunsaturated alcohol ethoxylate contains a hydrocarbon chains with two or more double bonds.

C18 alcohol ethoxylates may be synthesised by ethoxylation of an alkyl alcohol, via the reaction:
R_1-OH + *q* ethylene oxide → R_1-O-(CH_2CH_2O)$_q$-H

The alkyl alcohol may be produced by transesterification of the triglyceride to a methyl ester, followed by distillation and hydrogenation to the alcohol. The process is discussed in Journal of the American Oil Chemists' Society. 61 (2): 343–348 by Kreutzer, U. R. Preferred alkyl alcohol for the reaction is oleyl alcohol within an iodine value of 60 to 80, preferably 70 to 75, such alcohols are available from BASF, Cognis, Ecogreen and others.

Production of the fatty alcohol is futher discussed in Sanchez M.A. et al J.Chem.Technol.Biotechnol 2017; 92:27-92 and and Ullmann's Enzyclopaedie der technischen Chemie, Verlag Chemie, Weinheim, 4th Edition, Vol. 11, pages 436 et seq.

Preferably the ethoxylation reactions are base catalysed using NaOH, KOH, or $NaOCH_3$. Even more preferred are catalyst which provide narrower ethoxy distribution than NaOH, KOH, or $NaOCH_3$. Preferably these narrower distribution catalysts involve a Group II base such as Ba dodecanoate; Group II metal alkoxides; Group II hyrodrotalcite as described in WO2007/147866. Lanthanides may also be used. Such narrower distribution alcohol ethoxylates are available from Azo Nobel and Sasol.

Preferably the narrow ethoxy distribution has greater than 70 wt.%, more preferably greater than 80 wt% of the alcohol ethoxylate R-O-(CH_2CH_2O)$_q$-H in the range R-O-(CH_2CH_2O)$_x$-H to R-O-(CH_2CH_2O)$_y$-H where q is the mole average degree of ethoxylation and x and y are absolute numbers, where x = q-q/2 and y = q+q/2. For example when q=10, then greater than 70 wt.% of the alcohol ethoxylate should consist of ethoxylate with 5, 6, 7, 8, 9 10, 11, 12, 13, 14 and 15 ethoxylate groups.

However, depending on the source for the alkyl chain, it is preferred that the additional alcohol ethoxylate comprises C16 alcohol ethoxylate. More preferably, the saturated C16 alcohol ethoxylate comprises at least 90% wt. of the total C16 linear alcohol ethoxylate present.

Preferably, the proportion of monounsaturated C18 alcohol ethoxylate constitutes at least 50% wt. of the total C16 and C18 alcohol ethoxylate surfactant. However, where the level of C16 is above 30% the C18:1 level may be as low as 39%. Preferably, the C16 alcohol ethoxylate surfactant comprises at least 2% wt. and more preferably, from 4% of the total C16 and C18 alcohol ethoxylate surfactant. Preferably, the C16 saturated and C18 monounsaturated together comprise at least 75% wt. of the total alcohol ethoxylate and more preferably from 76 to 85% wt. of the total alcohol ethoxylate.

Preferably, the proportion of monounsaturated C18 constitutes at least 60% wt., most preferably at least 75 of the total C16 and C18 alcohol ethoxylate surfactant.

Preferably, the saturated C18 alcohol ethoxylate surfactant comprises up to 20% wt. and more preferably, up to 11% of the total C16 and C18 alcohol ethoxylate surfactant.

Preferably the saturated C18 content is at least 2% wt. of the total C16 and C18 alcohol ethoxylate content.

Preferably the weight fraction of C18 alcohol ethoxylate / C16 alcohol ethoxylate is greater than 1, more preferably from 2 to 100, most preferably 3 to 30. ‘C18 alcohol ethoxylate’ is the sum of all the C18 fractions in the alcohol ethoxylate and ‘C16 alcohol ethoxylate’ is the sum of all the C16 fractions in the alcohol ethoxylate.

C18 Alcohol ether sulfates:
Preferably, the composition comprises C18 ether sulfate of the formula:

$$R_2\text{-O-}(CH_2CH_2O)_pSO_3H$$

Where R_2 is selected from saturated, monounsaturated and polyunsaturated linear C18 alkyl chains and where p is from 3 to 20, preferably 4 to 12, more preferably 5 to 10. The mono-unsaturation is preferably in the 9 position of the chain, where the carbons are counted from the ethoxylate bound chain end. The double bond may be in a cis or trans configuration (oleyl or elaidyl), but is preferably cis. The cis or trans ether sulfate $CH_3(CH_2)_7$-CH=CH-$(CH_2)_8$O-$(CH_2CH_2O)_nSO_3H$, is described as C18:1(Δ9) ether sulfate. This follows the nomenclature C*X:Y(*Δ*Z*) where *X* is the number of carbons in the chain, *Y* is the number of double bonds and Δ*Z* the position of the double bond on the chain where the carbons are counted from the OH bound chain end.

Preferably, R2 is selected from saturated C18 and monounsaturated C18. As regards the C18 content, it is preferred that the predominant C18 moiety is C18:1, more preferably C18:1(Δ9).

Ether sulfates are discussed in the Anionic Surfactants: Organic Chemistry edited by Helmut W. Stache (Marcel Dekker 1995), Surfactant Science Series published by CRC press.

Linear saturated or mono-unsaturated C20 and C22 ether sulfate may also be present. Preferably the weight fraction of sum of ‘C18 ether sulfate’ / ’C20 and C22 ether sulfate’ is greater than 10.

Preferably the C18 ether sulfate contains less than 15 wt.%, more preferably less than 8 wt.%, most preferably less than 4wt% and most preferably less than 2% wt. of the ether sulfate polyunsaturated ether sulfate. A polyunsaturated ether sulfate contains a hydrocarbon chains with two or more double bonds.

Ether sulfate may be synthesised by the sulphonation of the corresponding alcohol ethoxylate. The alcohol ethoxylate may be produced by ethoxylation of an alkyl alcohol. The alkyl alcohol used to produced the alcohol ethoxylate may be produced by transesterification of the triglyceride to a methyl ester, followed by distillation and hydrogenation to the alcohol. The process is discussed in Journal of the American Oil Chemists' Society. 61 (2): 343–348 by Kreutzer, U. R. Preferred alkyl alcohol for the reaction is oleyl alcohol with an iodine value of 60 to 80, preferably 70 to 75, such alcohol are available from BASF, Cognis, Ecogreen.

The degree of polyunsaturation in the surfactant may be controlled by hydrogenation of the triglyceride as described in: A Practical Guide to Vegetable Oil Processing (Gupta M.K. Academic Press 2017). Distillation and other purification techniques may be used.

Ethoxylation reactions are described in Non-Ionic Surfactant Organic Chemistry (N. M. van Os ed), Surfactant Science Series Volume 72, CRC Press.

Preferably the ethoxylation reactions are base catalysed using NaOH, KOH, or $NaOCH_3$. Even more preferred are catalyst which provide narrower ethoxy distribution than NaOH, KOH, or $NaOCH_3$. Preferably these narrower distribution catalysts involve a Group II base such as Ba dodecanoate; Group II metal alkoxides; Group II hyrodrotalcite as described in WO2007/147866. Lanthanides may also be used. Such narrower distribution alcohol ethoxylates are available from Azo Nobel and Sasol.

Preferably the narrow ethoxy distribution has greater than 70 wt.%, more preferably greater than 80 wt% of the ether sulfate $R_2\text{-}O\text{-}(CH_2CH_2O)_pSO_3H$ in the range $R_2\text{-}O\text{-}(CH_2CH_2O)_zSO_3H$ to $R_2\text{-}O\text{-}(CH_2CH_2O)_wSO_3H$ where q is the mole average degree of ethoxylation and x and y are absolute numbers, where z = p-p/2 and w = p+p/2. For example when p=6, then greater than 70 wt.% of the ether sulfate should consist of ether sulfate with 3, 4, 5, 6, 7, 8, 9 ethoxylate groups.

The ether sulfate weight is calculated as the protonated form: $R_2\text{-}O\text{-}(CH_2CH_2O)_pSO_3H$. In the formulation it will be present as the ionic form $R_2\text{-}O\text{-}(CH_2CH_2O)_pSO_3^-$ with a corresponding counter ion, preferred counter ions are group I and II metals, amines, most preferably sodium.

The composition may also comprise C16 alkyl ether sulphate. This may be a consequence of active addition of C16 or by way of a component of the sourcing of the C18 raw material.

More preferably, the saturated C16 comprises at least 90% wt. of the C16 content linear alkyl.

Preferably, the proportion of monounsaturated C18 constitutes at least 50% wt. of the total C16 and C18 alkyl ether sulphate surfactant. However, where the level of C16 is above 30% the C18:1 level may be as low as 39%. Preferably, the C16 alcohol ether sulphate surfactant comprises at least 2% wt. and more preferably, from 4% of the total C16 and C18 alcohol ether sulphate surfactant. Preferably, the C16 saturated and C18 monounsaturated together comprise at least 75% wt. of the total alcohol ether sulphate and more preferably from 76 to 85% wt. of the total alcohol ether sulphate.

More preferably, the proportion of monounsaturated C18 constitutes at least 60% wt., most preferably at least 75 of the total C16 and C18 alkyl ether sulphate surfactant.

Preferably, the C16 alkyl ether sulphate surfactant comprises at least 2% wt. and more preferably, from 4% of the total C16 and C18 alkyl ether sulphate surfactant.

Preferably, the saturated C18 alkyl ether sulphate surfactant comprises up to 20% wt. and more preferably, up to11% of the total C16 and C18 alkyl ether sulphate surfactant. Preferably the saturated C18 content is at least 2% wt. of the total C16 and C18 alkyl ether sulphate content.

Where the composition comprises a mixture of the C16/18 sourced material for the alkyl ether sulphate as well as the more traditional C12 alkyl chain length materials it is preferred that the total C16/18 alkyl ether sulphate content should comprise at least 10% wt. of the total alkyl ether sulphate, more preferably at least 50%, even more preferably at least 70%, especially preferably at least 90% and most preferably at least 95% of alkyl ether sulphate in the composition.

Preferably, the weight ratio of total non-ionic surfactant to total alkyl ether sulphate surfactant (wt. non-ionic / wt. alkyl ether sulphate) is from 0.5 to 2, preferably from 0.7 to 1.5, most preferably 0.9 to 1.1.

Preferably, the weight ratio of total C16/18 non-ionic surfactant, to total alkyl ether sulphate surfactant (wt. non-ionic / wt. alkyl ether sulphate) is from 0.5 to 2, preferably from 0.7 to 1.5, most preferably 0.9 to 1.1.

Preferably, the weight ratio of total non-ionic surfactant to total C16/18 alkyl ether sulphate surfactant (wt. non-ionic / wt. alkyl ether sulphate) is from 0.5 to 2, preferably from 0.7 to 1.5, most preferably 0.9 to 1.1.

Preferably, the weight ratio of total C18:1 non-ionic surfactant to total C18:1 alkyl ether sulphate surfactant (wt. non-ionic / wt. alkyl ether sulphate) is from 0.5 to 2, preferably from 0.7 to 1.5, most preferably 0.9 to 1.1.

Preferably, the weight ratio of total non-ionic surfactant to linear alkyl benzene sulphonate, where present, (wt. non-ionic/ wt. linear alkyl benzene sulphonate) is from 0.1 to 2, preferably 0.3 to 1, most preferably 0.45 to 0.85.

Preferably, the weight ratio of total C16/18 non-ionic surfactant to linear alkyl benzene sulphonate, where present, (wt. non-ionic/ wt. linear alkyl benzene sulphonate) is from 0.1 to 2, preferably 0.3 to 1, most preferably 0.45 to 0.85.

Source of alkyl chains:
The alkyl chain of C16/18 surfactant whether an alcohol ethoxylate or an alkyl ether sulphate is preferably obtained from a renewable source, preferably from a triglyceride. A renewable source is one where the material is produced by natural ecological cycle of a living species, preferably by a plant, algae, fungi, yeast or bacteria, more preferably plants, algae or yeasts.

Preferred plant sources of oils are rapeseed, sunflower, maze, soy, cottonseed, olive oil and trees. The oil from trees is called tall oil. Most preferably Palm and Rapeseed oils are the source.

Algal oils are discussed in Energies 2019, 12, 1920 *Algal Biofuels: Current Status and Key Challenges* by Saad M.G. et al. A process for the production of triglycerides from biomass using yeasts is described in Energy Environ. Sci., 2019,12, 2717 *A sustainable, high-performance process for the economic production of waste-free microbial oils that can replace plant-based equivalents* by Masri M.A. et al.

Non edible plant oils may be used and are preferably selected from the fruit and seeds of Jatropha curcas, Calophyllum inophyllum, Sterculia feotida, Madhuca indica (mahua), Pongamia glabra (koroch seed), Linseed, Pongamia pinnata (karanja), Hevea brasiliensis (Rubber seed), Azadirachta indica (neem), Camelina sativa, Lesquerella fendleri, Nicotiana tabacum (tobacco), Deccan hemp, Ricinus communis L.(castor), Simmondsia chinensis (Jojoba), Eruca sativa. L., Cerbera odollam (Sea mango), Coriander (Coriandrum sativum L.), Croton megalocarpus, Pilu, Crambe, syringa, Scheleichera triguga (kusum), Stillingia, Shorea robusta (sal), Terminalia belerica roxb, Cuphea, Camellia, Champaca, Simarouba glauca, Garcinia indica, Rice bran, Hingan (balanites), Desert date, Cardoon, Asclepias syriaca (Milkweed), Guizotia abyssinica, Radish Ethiopian mustard, Syagrus, Tung, Idesia polycarpa var. vestita, Alagae, Argemone mexicana L. (Mexican prickly poppy, Putranjiva roxburghii (Lucky bean tree), Sapindus mukorossi (Soapnut), M. azedarach (syringe),Thevettia peruviana (yellow oleander), Copaiba, Milk bush, Laurel, Cumaru, Andiroba, Piqui, B. napus, Zanthoxylum bungeanum.

Fatty Acid:
Preferably, the liquid laundry composition comprises fatty acid. Preferably, the fatty acid is present at from 4 to 20% wt. of the composition (as measured with reference to the acid added to the composition), more preferably from 5 to 12% wt. and most preferably 6 to 8% wt.

Suitable fatty acids in the context of this invention include aliphatic carboxylic acids of formula RCOOH, where R is a linear or branched alkyl or alkenyl chain containing from 6 to 24, more preferably 10 to 22, most preferably from 12 to 18 carbon atoms and 0 or 1 double bond. Preferred examples of such materials include saturated C12-18 fatty acids such as lauric acid, myristic acid, palmitic acid or stearic acid; and fatty acid mixtures in which 50 to 100% (by weight based on the total weight of the mixture) consists of saturated C12-18 fatty acids. Such mixtures may typically be derived from natural fats and/or optionally hydrogenated natural oils (such as coconut oil, palm kernel oil or tallow).

The fatty acids may be present in the form of their sodium, potassium or ammonium salts and/or in the form of soluble salts of organic bases, such as mono-, di- or triethanolamine.

Mixtures of any of the above-described materials may also be used.

For formula accounting purposes, in the formulation, fatty acids and/or their salts (as defined above) are not included in the level of surfactant or in the level of builder.

Sequestrant:

The detergent compositions may also preferably comprise a sequestrant material. Examples include the alkali metal citrates, succinates, malonates, carboxymethyl succinates, carboxylates, polycarboxylates and polyacetyl carboxylates. Specific examples include sodium, potassium and lithium salts of oxydisuccinic acid, mellitic acid, benzene polycarboxylic acids, and citric acid. Other examples are DEQUEST™, organic phosphonate type sequestering agents sold by Monsanto and alkanehydroxy phosphonates.

A preferred sequestrant is Dequest(R) 2066 (Diethylenetriamine penta(methylene phosphonic acid or Heptasodium DTPMP). HEDP (1 -Hydroxyethylidene -1,1,-diphosphonic acid), is preferably not present.

In a preferred embodiment the composition comprises fatty acid and sequestrant.

The composition according to the invention is a low aqueous composition. Preferably, the composition comprises less than 15% wt. water, more preferably less than 10% wt. water.

Preservative:

Food preservatives are discussed In Food Chemistry (Belitz H.-D., Grosch W., Schieberle), 4th edition Springer.

The formulation contains a preservative or a mixture of preservatives, selected from benzoic acid and salts thereof, alkylesters of p-hydroxybenzoic acid and salts thereof, sorbic acid, diethyl pyrocarbonate, dimethyl pyrocarbonate, preferably benzoic acid and salts thereof, most preferably sodium benzoate. The preservative is present at 0.01 to 3wt%, preferably 0.3wt% to 1.5w%. Weights are calculated for the protonated form.

Cleaning polymers:

Anti-redeposition polymers stabilise the soil in the wash solution thus preventing redeposition of the soil. Suitable soil release polymers for use in the invention include alkoxylated polyethyleneimines. Polyethyleneimines are materials composed of ethylene imine units -CH_2CH_2NH- and, where branched, the hydrogen on the nitrogen is replaced by another chain of ethylene imine units. Preferred alkoxylated polyethyleneimines for use in the invention have a polyethyleneimine backbone of about 300 to about 10000 weight average molecular weight (M_w). The polyethyleneimine backbone may be linear or branched. It may be branched to the extent that it is a dendrimer. The alkoxylation may typically be ethoxylation or propoxylation, or a mixture of both. Where a nitrogen atom is alkoxylated, a preferred average degree of alkoxylation is from 10 to 30, preferably from 15 to 25 alkoxy groups per modification. A preferred material is ethoxylated polyethyleneimine, with an average degree of ethoxylation being from 10 to 30, preferably from 15 to 25 ethoxy groups per ethoxylated nitrogen atom in the polyethyleneimine backbone.

Mixtures of any of the above-described materials may also be used.

A composition of the invention will preferably comprise from 0.025 to 8% wt. of one or more anti-redeposition polymers such as, for example, the alkoxylated polyethyleneimines which are described above.

Soil release polymers:

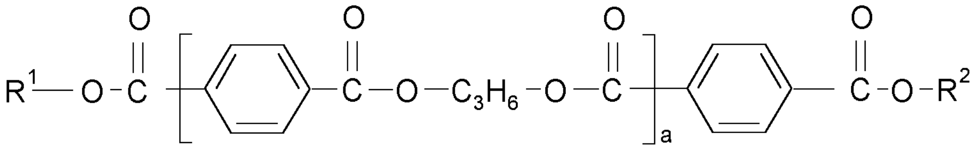
Soil release polymers help to improve the detachment of soils from fabric by modifying the fabric surface during washing. The adsorption of a SRP over the fabric surface is promoted by an affinity between the chemical structure of the SRP and the target fibre.

SRPs for use in the invention may include a variety of charged (e.g. anionic) as well as non-charged monomer units and structures may be linear, branched or star-shaped. The SRP structure may also include capping groups to control molecular weight or to alter polymer properties such as surface activity. The weight average molecular weight (M_w) of the SRP may suitably range from about 1000 to about 20,000 and preferably ranges from about 1500 to about 10,000.

SRPs for use in the invention may suitably be selected from copolyesters of dicarboxylic acids (for example adipic acid, phthalic acid or terephthalic acid), diols (for example ethylene glycol or propylene glycol) and polydiols (for example polyethylene glycol or polypropylene glycol). The co-polyester may also include monomeric units substituted with anionic groups, such as for example sulfonated isophthaloyl units. Examples of such materials include oligomeric esters produced by transesterification/oligomerization of poly(ethyleneglycol) methyl ether, dimethyl terephthalate ("DMT"), propylene glycol ("PG") and poly(ethyleneglycol) ("PEG"); partly- and fully-anionic-end-capped oligomeric esters such as oligomers from ethylene glycol ("EG"), PG, DMT and Na-3,6-dioxa-8-hydroxyoctanesulfonate; non-ionic-capped block polyester oligomeric compounds such as those 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 copolymeric blocks of ethylene terephthalate or propylene terephthalate with polyethylene oxide or polypropylene oxide terephthalate.

Other types of SRP for use in the invention include cellulosic derivatives such as hydroxyether cellulosic polymers, C_1-C_4 alkylcelluloses and C_4 hydroxyalkyl celluloses; polymers with poly(vinyl ester) hydrophobic segments such as graft copolymers of poly(vinyl ester), for example C_1-C_6 vinyl esters (such as poly(vinyl acetate)) grafted onto polyalkylene oxide backbones; poly(vinyl caprolactam) and related co-polymers with monomers such as vinyl pyrrolidone and/or dimethylaminoethyl methacrylate; and polyester-polyamide polymers prepared by condensing adipic acid, caprolactam, and polyethylene glycol.

Preferred SRPs for use in the invention include copolyesters formed by condensation of terephthalic acid ester and diol, preferably 1,2 propanediol, and further comprising an end cap formed from repeat units of alkylene oxide capped with an alkyl group. Examples of such materials have a structure corresponding to general formula (I):



(I)

in which R^1 and R^2 independently of one another are $X\text{-}(OC_2H_4)_n\text{-}(OC_3H_6)_m$;

in which X is $C_{1\text{-}4}$ alkyl and preferably methyl;

n is a number from 12 to 120, preferably from 40 to 50;

m is a number from 1 to 10, preferably from 1 to 7; and

a is a number from 4 to 9.

Because they are averages, m, n and a are not necessarily whole numbers for the polymer in bulk.

Mixtures of any of the above-described materials may also be used.

The overall level of SRP, when included, may range from 0.1 to 10%, depending on the level of polymer intended for use in the final diluted composition and which is desirably from 0.3 to 7%, more preferably from 0.5 to 5% (by weight based on the total weight of the diluted composition).

Suitable soil release polymers are described in greater detail in U. S. Patent Nos. 5,574,179; 4,956,447; 4,861,512; 4,702,857, WO 2007/079850 and WO2016/005271. If employed, soil release polymers will typically be incorporated into the liquid laundry detergent compositions herein in concentrations ranging from 0.01 percent to 10 percent, more preferably from 0.1 percent to 5 percent, by weight of the composition.

Hydrotrope:

A composition of the invention may incorporate non-aqueous carriers such as hydrotropes, co-solvents and phase stabilizers. Such materials are typically low molecular weight, water-soluble or water-miscible organic liquids such as C1 to C5 monohydric alcohols (such as ethanol and n- or i-propanol); C2 to C6 diols (such as monopropylene glycol and dipropylene glycol); C3 to C9 triols (such as glycerol); polyethylene glycols having a weight average molecular weight (M_w) ranging from about 200 to 600; C1 to C3 alkanolamines such as mono-, di- and triethanolamines; and alkyl aryl sulfonates having up to 3 carbon atoms in the lower alkyl group (such as the sodium and potassium xylene, toluene, ethylbenzene and isopropyl benzene (cumene) sulfonates).

Mixtures of any of the above-described materials may also be used.

Non-aqueous carriers, are preferably included, may be present in an amount ranging from 1 to 50%, preferably from 10 to 30%, and more preferably from 15 to 25% (by weight based on the total weight of the composition). The level of hydrotrope used is linked to the level of surfactant and it is desirable to use hydrotrope level to manage the viscosity in such compositions. The preferred hydrotropes are monopropylene glycol and glycerol.

Cosurfactant:

A composition of the invention may contain one or more cosurfactants (such as amphoteric (zwitterionic) and/or cationic surfactants) in addition to the non-soap anionic and/or nonionic detersive surfactants described above.

Specific cationic surfactants include C8 to C18 alkyl dimethyl ammonium halides and derivatives thereof in which one or two hydroxyethyl groups replace one or two of the methyl groups, and mixtures thereof. Cationic surfactant, when included, may be present in an amount ranging from 0.1 to 5% (by weight based on the total weight of the composition).

Specific amphoteric (zwitterionic) surfactants include alkyl amine oxides, alkyl betaines, alkyl amidopropyl betaines, alkyl sulfobetaines (sultaines), alkyl glycinates, alkyl carboxyglycinates, alkyl amphoacetates, alkyl amphopropionates, alkylamphoglycinates, alkyl amidopropyl hydroxysultaines, acyl taurates and acyl glutamates, having alkyl radicals containing from about 8 to about 22 carbon atoms preferably selected from C12, C14, C16 ,C18 and C18:1, the term “alkyl” being used to include the alkyl portion of higher acyl radicals. Amphoteric (zwitterionic) surfactant, when included, may be present in an amount ranging from 0.1 to 5% (by weight based on the total weight of the composition).

Mixtures of any of the above described materials may also be used.

Fluorescent agent:
It may be advantageous to include fluorescer in the compositions. Usually, these fluorescent agents are supplied and used in the form of their alkali metal salts, for example, the sodium salts. The total amount of the fluorescent agent or agents used in the composition is generally from 0.005 to 2 wt %, more preferably 0.01 to 0.5 wt % the composition.

Preferred classes of fluorescer are: Di-styryl biphenyl compounds, e.g. Tinopal ® CBS-X, Di-amine stilbene di-sulphonic acid compounds, e.g. Tinopal DMS pure Xtra, Tinopal 5BMGX, and Blankophor ® HRH, and Pyrazoline compounds, e.g. Blankophor SN.

Preferred fluorescers are: sodium 2 (4-styryl-3-sulfophenyl)-2H-napthol[1,2-d]triazole, disodium 4,4'-bis{[(4-anilino-6-(N methyl-N-2 hydroxyethyl) amino 1,3,5-triazin-2-yl)]amino}stilbene-2-2' disulfonate, disodium 4,4'-bis{[(4-anilino-6-morpholino-1,3,5-triazin-2-yl)]amino} stilbene-2-2' disulfonate, and disodium 4,4'-bis(2-sulfoslyryl)biphenyl.

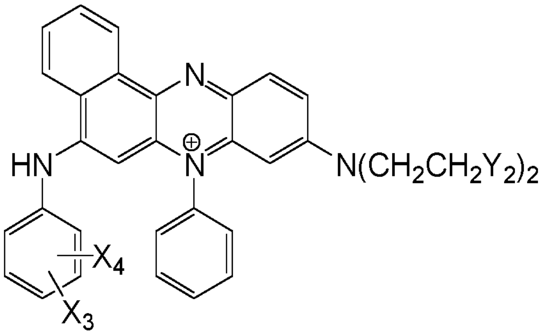
Most preferably the fluoescer is a di-styryl biphenyl compound, preferably sodium 2,2'-([1,1'-biphenyl]-4,4'-diylbis(ethene-2,1-diyl))dibenzenesulfonate (CAS-No 27344-41-8).

Shading dyes:

Shading dye can be used to improve the performance of the compositions. Preferred dyes are violet or blue. It is believed that the deposition on fabrics of a low level of a dye of these shades, masks yellowing of fabrics. A further advantage of shading dyes is that they can be used to mask any yellow tint in the composition itself.

Shading dyes are well known in the art of laundry liquid formulation.

Suitable and preferred classes of dyes include direct dyes, acid dyes, hydrophobic dyes, basic dyes, reactive dyes and dye conjugates. Preferred examples are Disperse Violet 28, Acid Violet 50, anthraquinone dyes covalently bound to ethoxylate or propoxylated polyethylene imine as described in WO2011/047987 and WO 2012/119859, alkoxylated mono-azo thiophenes, dye with CAS-No 72749-80-5, acid blue 59, and the phenazine dye selected from:



wherein:

X_3 is selected from: -H; -F; $-CH_3$; $-C_2H_5$; $-OCH_3$; and, $-OC_2H_5$;

X_4 is selected from: -H; $-CH_3$; $-C_2H_5$; $-OCH_3$; and, $-OC_2H_5$;

Y_2 is selected from: –OH; $-OCH_2CH_2OH$; $-CH(OH)CH_2OH$; $-OC(O)CH_3$; and, $C(O)OCH_3$.

Alkoxylated thiophene dyes are discussed in WO2013/142495 and WO2008/087497.

The shading dye is preferably present is present in the composition in range from 0.0001 to 0.1wt %. Depending upon the nature of the shading dye there are preferred ranges depending upon the efficacy of the shading dye which is dependent on class and particular efficacy within any particular class.

External structurant:

Compositions of the invention may have their rheology further modified by use of one or more external structurants which form a structuring network within the composition. Examples of such materials include hydrogenated castor oil, microfibrous cellulose and citrus pulp fibre. The presence of an external structurant may provide shear thinning rheology and may also enable materials such as encapsulates and visual cues to be suspended stably in the liquid.

Enzymes:

Preferably the enzyme according to the present invention in a liquid laundry composition is present in an effective amount selected from the group comprising, pectate lyase, protease, amylase, cellulase, lipase, mannanase, nuclease and mixtures thereof. The enzymes are preferably present along with corresponding enzyme stabilizers.

Microcapsules:

One type of microparticle suitable for use in the invention is a microcapsule. Microencapsulation may be defined as the process of surrounding or enveloping one substance within another substance on a very small scale, yielding capsules ranging from less than one micron to several hundred microns in size. The material that is encapsulated may be called the core, the active ingredient or agent, fill, payload, nucleus, or internal phase. The material encapsulating the core may be referred to as the coating, membrane, shell, or wall material.

Microcapsules typically have at least one generally spherical continuous shell surrounding the core. The shell may contain pores, vacancies or interstitial openings depending on the materials and encapsulation techniques employed. Multiple shells may be made of the same or different encapsulating materials, and may be arranged in strata of varying thicknesses around the core. Alternatively, the microcapsules may be asymmetrically and variably shaped with a quantity of smaller droplets of core material embedded throughout the microcapsule.

The shell may have a barrier function protecting the core material from the environment external to the microcapsule, but it may also act as a means of modulating the release of core materials such as fragrance. Thus, a shell may be water soluble or water swellable and fragrance release may be actuated in response to exposure of the microcapsules to a moist environment. Similarly, if a shell is temperature sensitive, a microcapsule might release fragrance in response to elevated temperatures. Microcapsules may also release fragrance in response to shear forces applied to the surface of the microcapsules.

A preferred type of polymeric microparticle suitable for use in the invention is a polymeric core-shell microcapsule in which at least one generally spherical continuous shell of polymeric material surrounds a core containing the fragrance formulation (f2). The shell will typically comprise at most 20% by weight based on the total weight of the microcapsule. The fragrance formulation (f2) will typically comprise from about 10 to about 60% and preferably from about 20 to about 40% by weight based on the total weight of the microcapsule. The amount of fragrance (f2) may be measured by taking a slurry of the microcapsules, extracting into ethanol and measuring by liquid chromatography.

Polymeric core-shell microcapsules for use in the invention may be prepared using methods known to those skilled in the art such as coacervation, interfacial polymerization, and polycondensation.

The process of coacervation typically involves encapsulation of a generally water-insoluble core material by the precipitation of colloidal material(s) onto the surface of droplets of the material. Coacervation may be simple e.g. using one colloid such as gelatin, or complex where two or possibly more colloids of opposite charge, such as gelatin and gum arabic or gelatin and carboxymethyl cellulose, are used under carefully controlled conditions of pH, temperature and concentration.

Interfacial polymerisation typically proceeds with the formation of a fine dispersion of oil droplets (the oil droplets containing the core material) in an aqueous continuous phase. The dispersed droplets form the core of the future microcapsule and the dimensions of the dispersed droplets directly determine the size of the subsequent microcapsules. Microcapsule shell-forming materials (monomers or oligomers) are contained in both the dispersed phase (oil droplets) and the aqueous continuous phase and they react together at the phase interface to build a polymeric wall around the oil droplets thereby to encapsulate the droplets and form core-shell microcapsules. An example of a core-shell microcapsule produced by this method is a polyurea microcapsule with a shell formed by reaction of diisocyanates or polyisocyanates with diamines or polyamines.

Polycondensation involves forming a dispersion or emulsion of the core material in an aqueous solution of precondensate of polymeric materials under appropriate conditions of agitation to produce capsules of a desired size, and adjusting the reaction conditions to cause condensation of the precondensate by acid catalysis, resulting in the condensate separating from solution and surrounding the dispersed core material to produce a coherent film and the desired microcapsules. An example of a core-shell microcapsule produced by this method is an aminoplast microcapsule with a shell formed from the polycondensation product of melamine (2,4,6-triamino-1,3,5-triazine) or urea with formaldehyde. Suitable cross-linking agents (e.g. toluene diisocyanate, divinyl benzene, butanediol diacrylate) may also be used and secondary wall polymers may also be used as appropriate, e.g. anhydrides and their derivatives, particularly polymers and co-polymers of maleic anhydride.

One example of a preferred polymeric core-shell microcapsule for use in the invention is an aminoplast microcapsule with an aminoplast shell surrounding a core containing the fragrance formulation (f2). More preferably such an aminoplast shell is formed from the polycondensation product of melamine with formaldehyde.

Polymeric microparticles suitable for use in the invention will generally have an average particle size between 100 nanometers and 50 microns. Particles larger than this are entering the visible range. Examples of particles in the sub-micron range include latexes and mini-emulsions with a typical size range of 100 to 600 nanometers. The preferred particle size range is in the micron range. Examples of particles in the micron range include polymeric core-shell microcapsules (such as those further described above) with a typical size range of 1 to 50 microns, preferably 5 to 30 microns. The average particle size can be determined by light scattering using a Malvern Mastersizer with the average particle size being taken as the median particle size D (0.5) value. The particle size distribution can be narrow, broad or multimodal. If necessary, the microcapsules as initially produced may be filtered or screened to produce a product of greater size uniformity.

Polymeric microparticles suitable for use in the invention may be provided with a deposition aid at the outer surface of the microparticle. Deposition aids serve to modify the properties of the exterior of the microparticle, for example to make the microparticle more substantive to a desired substrate. Desired substrates include cellulosics (including cotton) and polyesters (including those employed in the manufacture of polyester fabrics).

The deposition aid may suitably be provided at the outer surface of the microparticle by means of covalent bonding, entanglement or strong adsorption. Examples include polymeric core-shell microcapsules (such as those further described above) in which a deposition aid is attached to the outside of the shell, preferably by means of covalent bonding. While it is preferred that the deposition aid is attached directly to the outside of the shell, it may also be attached via a linking species.

Deposition aids for use in the invention may suitably be selected from polysaccharides having an affinity for cellulose. Such polysaccharides may be naturally occurring or synthetic and may have an intrinsic affinity for cellulose or may have been derivatised or otherwise modified to have an affinity for cellulose. Suitable polysaccharides have a 1-4 linked β glycan (generalised sugar) backbone structure with at least 4, and preferably at least 10 backbone residues which are β1-4 linked, such as a glucan backbone (consisting of β1-4 linked glucose residues), a mannan backbone (consisting of β1-4 linked mannose residues) or a xylan backbone (consisting of β1-4 linked xylose residues). Examples of such β1-4 linked polysaccharides include xyloglucans, glucomannans, mannans, galactomannans, β(1-3),(1-4) glucan and the xylan family incorporating glucurono-, arabino- and glucuronoarabinoxylans. Preferred β1-4 linked polysaccharides for use in the invention may be selected from xyloglucans of plant origin, such as pea xyloglucan and tamarind seed xyloglucan (TXG) (which has a β1-4 linked glucan backbone with side chains of α-D xylopyranose and β-D-galactopyranosyl-(1-2)-α-D-xylo-pyranose, both 1-6 linked to the backbone); and galactomannans of plant origin such as loc ust bean gum (LBG) (which has a mannan backbone of β1-4 linked mannose residues, with single unit galactose side chains linked α1-6 to the backbone).

Also suitable are polysaccharides which may gain an affinity for cellulose upon hydrolysis, such as cellulose mono-acetate; or modified polysaccharides with an affinity for cellulose such as hydroxypropyl cellulose, hydroxypropyl methylcellulose, hydroxyethyl methylcellulose, hydroxypropyl guar, hydroxyethyl ethylcellulose and methylcellulose.

Deposition aids for use in the invention may also be selected from phthalate containing polymers having an affinity for polyester. Such phthalate containing polymers may have one or more nonionic hydrophilic segments comprising oxyalkylene groups (such as oxyethylene, polyoxyethylene, oxypropylene or polyoxypropylene groups), and one or more hydrophobic segments comprising terephthalate groups. Typically, the oxyalkylene groups will have a degree of polymerization of from 1 to about 400, preferably from 100 to about 350, more preferably from 200 to about 300. A suitable example of a phthalate containing polymer of this type is a copolymer having random blocks of ethylene terephthalate and polyethylene oxide terephthalate.

Mixtures of any of the above described materials may also be suitable.

Deposition aids for use in the invention will generally have a weight average molecular weight (M_w) in the range of from about 5 kDa to about 500 kDa, preferably from about 10 kDa to about 500 kDa and more preferably from about 20 kDa to about 300 kDa.

One example of a particularly preferred polymeric core-shell microcapsule for use in the invention is an aminoplast microcapsule with a shell formed by the polycondensation of melamine with formaldehyde; surrounding a core containing the fragrance formulation (f2); in which a deposition aid is attached to the outside of the shell by means of covalent bonding. The preferred deposition aid is selected from β1-4 linked polysaccharides, and in particular the xyloglucans of plant origin, as are further described above.

The present inventors have surprisingly observed that it is possible to reduce the total level of fragrance included in the composition of the invention without sacrificing the overall fragrance experience delivered to the consumer at key stages in the laundry process. A reduction in the total level of fragrance is advantageous for cost and environmental reasons.

Accordingly, the total amount of fragrance formulation (f1) and fragrance formulation (f2) in the composition of the invention suitably ranges from 0.5 to 1.4%, preferably from 0.5 to 1.2%, more preferably from 0.5 to 1% and most preferably from 0.6 to 0.9% (by weight based on the total weight of the composition).

The weight ratio of fragrance formulation (f1) to fragrance formulation (f2) in the composition of the invention preferably ranges from 60:40 to 45:55. Particularly good results have been obtained at a weight ratio of fragrance formulation (f1) to fragrance formulation (f2) of around 50:50.

The fragrance (f1) and fragrance (f2) are typically incorporated at different stages of formation of the composition of the invention. Typically, the discrete polymeric microparticles (e.g. microcapsules) entrapping fragrance formulation (f2) are added in the form of a slurry to a warmed base formulation comprising other components of the composition (such as surfactants and solvents). Fragrance (f1) is typically post-dosed later after the base formulation has cooled.

Further optional ingredients:
A composition of the invention may contain further optional ingredients to enhance performance and/or consumer acceptability. Examples of such ingredients include foam boosting agents, preservatives (e.g. bactericides), polyelectrolytes, anti-shrinking agents, anti-wrinkle agents, anti-oxidants, sunscreens, anti-corrosion agents, drape imparting agents, anti-static agents, ironing aids, colorants, pearlisers and/or opacifiers, and shading dye. Each of these ingredients will be present in an amount effective to accomplish its purpose. Generally, these optional ingredients are included individually at an amount of up to 5% (by weight based on the total weight of the diluted composition) and so adjusted depending on the dilution ratio with water.

Solid laundry composition:

A solid laundry composition according to the present disclosure encompasses a variety of spray-dried or granulated forms including, for example powder, particulates; cast and extruded forms including, for example, solids, pellets, blocks, bars, and tablets. It should be understood that the term “solid” refers to the state of the detergent composition under the expected conditions of storage and use of the solid detergent composition. In general, it is expected that the detergent composition will remain a solid when provided at a temperature of up to about 37°C and preferably greater than 50°C.

The composition according to the present invention preferably has a pH from 7.0 to 13, preferably 7.0 to 10.5, still preferably 7.0 to 10.2, still further preferably from 8.5 to 10.2, when measured at 1 wt.% dilution in de-ionised water at 25°C. The composition may preferably include a buffer.

The solid composition according to the present invention may be made via a variety of conventional methods known in the art and includes but is not limited to the mixing of ingredients, including dry-mixing, compaction such as agglomerating, extrusion, tabletting, or spray-drying of the various compounds comprised in the detergent component, or mixtures of these techniques, whereby the components herein also can be made by for example compaction, including extrusion and agglomerating, or spray-drying. The detergent composition may be made by any of the conventional processes, especially preferred is the technique of slurry making and spray drying.

The compositions herein can take a variety of physical solid forms including forms such as powder, granule, ribbon, noodle, paste, tablet, flake, pastille and bar, and preferably the composition is in the form of powder, granules or a tablet, still preferably the composition is in the form of a powder. The composition may be in the form of a unit dose formulation, delayed delivery formulation, detergent contained on or in a porous substrate or nonwoven sheet, and other suitable forms that may be apparent to one skilled in the art in view of the teachings herein. The composition according to the present invention may preferably be in a form selected from powder, pellets, granules, tablet, bar or flake.

The solid laundry detergent composition according to the present invention is preferably free flowing. The solid detergent composition preferably includes but is not limited to powder, granular, particulate, agglomerates, noodles, flakes, tablets, bar, woven sheet, non-woven sheet or other solid forms known in the art and combinations thereof.

Preferably the composition is used for laundering fabrics in a machine or using a manual-washing method. Preferably the composition is in the form of a spray-dried powder or particulate free-flowing form.

Preferably the solid laundry composition is prepared by a spray-drying process. The spray-drying is carried out using any of the conventional spray drying system known in the art. Preferably in the spray drying system the aqueous slurry having LAS obtained from waste plastic feedstock and LAS obtained from petroleum feedstock is transferred through a pipe system to a pump system consisting of one or more pump and then further to a spray nozzle through which the slurry is released under pressure into a drying tower.

A typical spray-drying process involves the step of transferring the aqueous slurry through a pipe system leading to a first pump and then through a second pump and from a second pump to a plurality of spray nozzles. The first pump is typically a low-pressure pump, such as a pump that can generate a pressure of from $1\text{x}10^5$ Nm^{-2} to $1\text{x}10^6$ Nm^{-2}, which ensures proper flooding of the second pump. Typically, the second pump is a high-pressure pump, such as a pump that can generate a pressure ranging from $2\text{x}10^6\text{Nm}^{-2}$ to $2\text{x}10^7\text{Nm}^{-2}$. Optionally, the aqueous slurry may be transferred through bolt catchers, magnetic filters, lump breakers, disintegrators such as the Ritz Mill, during the transfer of the aqueous slurry through the pipe system downstream the pump system or the mixer in which the aqueous slurry is formed. The disintegrator is preferably positioned between the pumps. The flow rate of the aqueous slurry along the pipes is typically in the range from 800 Kg/hour to more than 75,000 Kg/hour.

Optionally, the spray drying system may include a deaeration system. The deaeration system is preferably a vacuum assisted de-aerator, which is preferably fed by a transfer pump. The deaeration system remove air bubbles formed during the slurry preparation, thus increasing the bulk density of the spray-dried powder. De-aeration of the slurry may also be carried out by other mechanical means or chemical de-aeration means using antifoams or de-foamers.

Optionally, air injection system may be provided along the pipe system. The air injection system may be provided before or after the pump system. The air injection includes air flow and pressure controls, static mixer, pulsation dampener and compressor set which can aerate the slurry to get a lower bulk density for the spray-dried powder. The gas injected into the slurry may be nitrogen, carbon dioxide, or simply atmospheric air introduced under a pressure higher than the pressure of the aqueous slurry maintained in the pipe system. A typical spray drying system can optionally include both the de-aeration system and air injection system to optimize the desired bulk density of the spray-dried powder.

Typical spray drying tower for detergent applications are counter-current spray drying tower. To obtain the desired moisture content and the particle size distribution the inlet hot air or hot steam temperature introduced into the spray drying tower is the range from 250°C to 500°C depending on the evaporation capacity and sizing of the tower. Preferably the tower exhaust air temperature can range from 60°C to 200°C, more preferably 80°C to 200°C, still more preferably 80°C to 100°C depending on the loading of the tower. The aqueous slurry introduced into the spray nozzle of the spray drying tower is preferably at a temperature ranging from 60°C to 95°C. The spray drying tower may be a co-current spray drying tower, but they are less common. The spray-dried powder existing the tower is maintained at a temperature less than 150°C, still preferably less than 100°C. The spray-drying is preferably conducted in the spray drying zone under a negative pressure of at least 50 Nm^{-2}, still preferably the negative pressure is from 50 Nm^{-2} to 600 Nm^{-2}. Preferably, the vacuum conditions are achieved by controlling the speed setting of the dampener of either or both the inlet and the outlet air fan.

The spray-dried powder collected at the bottom of the tower may be subjected to cooling and conditioning by using an air lift or other similar process known to a person skilled in the art for cooling and conditioning spray-dried particle. The spray-dried powder collected from the bottom of the spray-drying tower is preferably mixed with a flow aid chosen from zeolite or similar fine mineral particles selected from the group consisting of dolomite, calcite or mixtures thereof, just before being air-lifted. Preferably, the spray-dried powder is subject to particle size classification to remove oversize material (> 2 mm typically) to provide a spray dried detergent particle which is free flowing. Preferably the fine material (< 100 microns typically) is elutriated with the exhaust air in the spray drying tower and captured and recycled back into the system via the dry cyclone, wet cyclone or bag filter system.

The compositions preferably have a density of more than 350 grams/litre, more preferably more than 450 grams/litre or even more than 570 grams/litre.

The solid laundry composition according to the present invention preferably has from 0 wt.% to 8 wt.% zeolite builder. Preferably the amount of zeolite builder is less than 5 wt.%, still preferably less than 3 wt.%, more preferably less than 2 wt.% by weight in the detergent composition and most preferably the detergent composition is substantially free of zeolite builder.

The solid laundry detergent composition according to the present invention preferably has from 0 wt.% to 4 wt.% phosphate builder. Preferably the amount of phosphate builder is less than 3 wt.%, still preferably less than 2 wt.%, more preferably less than 1 wt.% by weight in the detergent composition and most preferably the detergent composition is substantially free of phosphate builder.

The term “substantially free” means that the indicated component is at the very minimum, not deliberately added to the composition to form part of it, or, more typically, is not present at analytically detectable levels. It is meant to include compositions whereby the indicated material is present only as an impurity in one of the other materials deliberately included.

Other laundry active ingredients

The solid laundry composition may include one or more of the following ingredients selected from additional surfactant, polymers, enzymes, builder, sequestrant, optical brighteners, perfumes, bleach, bleach activators, antifoams, shading or hueing dyes, pH buffering agents, perfume carriers, hydrotropes, cleaning polymers, care polymers, anti-redeposition agents, soil-release agents, anti-shrinking agents, anti-wrinkle agents, dyes, colorants and visual cues.

Additional surfactant:

The additional surfactant includes anionic surfactant other than LAS, cationic surfactant, amphoteric surfactant, zwitterionic surfactant, further nonionic surfactant or combinations thereof.

Examples of further anionic surfactant are given in "Surface Active Agents and Detergents" (Vol. I and II by Schwartz, Perry and Berch).

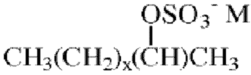
Suitable anionic surfactants include those selected from the group consisting of alkyl sulfates, alkyl sulfonates, alkylaryl sulfonates, alkyl sulfosuccinates, alkyl ether sulfosuccinates, alkyl sulfosuccinamates, alkyl amidosulfosuccinates, alkyl carboxylates, alkyl amido ether carboxylates, alkyl succinates, fatty acyl sarcosinates, fatty acyl amino acids, fatty acyl taurates, fatty alkyl sulfoacetates, alkyl phosphates, and mixtures of two or more thereof. Non-limiting examples of the preferred anionic surfactant includes linear alkyl benzene sulphonate, primary alkyl sulfate, methyl ester sulphonate or combinations thereof.

Nonlimiting examples of anionic surfactants useful herein include: C_{10} to C_{20} primary, branched chain and random alkyl sulfates (AS); mid-chain branched alkyl sulfates as discussed in US 6,020,303 and US 6,060,443; mid-chain branched alkyl alkoxy sulfates as discussed in

US 6,008, 181 and US 6,020,303; modified alkylbenzene sulfonate (MLAS) as discussed in WO 99/05243, WO 99/05242 and WO 99/05244; methyl ester sulfonate (MES); and alpha-olefin sulfonate (AOS).

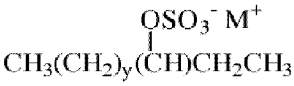
Conventional primary alkyl sulfate surfactants have the general formula: $R''OSO_3^-M^+$ wherein R'' is typically a C_8 to C_{20} alkyl (linear or branched, saturated or unsaturated) group, which may be straight chain or branched chain, and M is a water-solubilizing cation. In specific embodiments, R'' is a C_{10} to C_{15} alkyl group, and M is alkali metal, more specifically R'' is C_{12} to C_{14} alkyl and M is sodium. Examples include sodium lauryl sulphate, ammonium lauryl sulphate and sodium coco sulphate.

Specific, non-limiting examples of anionic surfactants useful herein include: a) C_{10} to C_{20} primary, branched-chain and random alkyl sulfates (AS); b) C_{10} to C_{18} secondary (2,3)-alkyl sulfates having following formulae:



$$CH_3(CH_2)_x\overset{\overset{\displaystyle OSO_3^-\,M^+}{|}}{(CH)}CH_3$$

or



$$CH_3(CH_2)_y\overset{\overset{\displaystyle OSO_3^-\,M^+}{|}}{(CH)}CH_2CH_3$$

wherein M is hydrogen or a cation which provides charge neutrality, and all M units, whether associated with a surfactant or adjunct ingredient, can either be a hydrogen atom or a cation depending upon the form isolated by the artisan or the relative pH of the system wherein the compound is used, with non-limiting examples of preferred cations including sodium, potassium, ammonium, and mixtures thereof, and x is an integer of at least about 7, preferably at least about 9, and y is an integer of at least 8, preferably at least about 9; c) C_{10} to C_{18} alkyl alkoxy sulfates (AES) wherein preferably z is from 1 to 30; d) C_{10} to C_{18} alkyl alkoxy carboxylates preferably comprising 1 to 5 ethoxy units; f) mid-chain branched alkyl sulfates as discussed in U.S. Patent Nos. 6,020,303 and 6,060,443; e) mid-chain branched alkyl alkoxy sulfates as discussed in U.S. Patent Nos. 6,008,181 and 6,020,303; f) modified alkylbenzene sulfonate (MLAS) as discussed in WO 99/05243, WO 99/05242, WO 99/05244, WO 99/05082, WO 99/05084, WO 99/05241, WO 99/07656, WO 00/23549, and WO 00/23548. ; g) methyl ester sulfonate (MES); and h) alphaolefin sulfonate (AOS). The additional anionic surfactant may be liner, branched or combinations thereof.

Anionic surfactants may exist in an acid form and the acid form may be neutralized to form a surfactant salt. Typical agents for neutralization include a metal counter ion base such as a hydroxide, e.g., NaOH or KOH. Further agents for neutralizing anionic surfactants include ammonia, amines, or alkanolamines. Suitable non-limiting examples include monoethanolamine, diethanolamine, triethanolamine, and other linear or branched alkanolamines known in the art, for example, 2-amino-1-propanol, 1-aminopropanol, monoisopropanolamine, or 1-amino-3-propanol.

Preferably the anionic surfactant is a non-soap anionic surfactant. The term “soap” is used herein in its popular sense, i.e., the alkali metal or alkanol ammonium salts of aliphatic, alkanes, or alkene monocarboxylic acids.

Preferably the anionic surfactant includes 0 wt.% to 20 wt.% alkyl sulfates, preferably 0 wt.% to 15 wt.% alkyl sulfates, preferably 0 wt.% to 10 wt.% alkyl sulfates, preferably PAS. The anionic surfactant may also include from 0 wt.% to 10 wt.% MES, preferably 0 wt.% to 5 wt.% MES.

The detergent composition of the present invention includes from 2 wt.% to 50 wt.% of an anionic surfactant, more preferably from 2 wt.% to 40 wt.% of an anionic surfactant. Preferably the detergent composition comprises at least 4 wt.%, still preferably at least 5 wt.%, still preferably at least 10 wt.%, most preferably at least 15 wt.% of the anionic surfactant, but typically not more than 45 wt.%, still preferably not more than 40 wt.%, still further preferably not more than 35 wt.%, still more preferably not more than 30 wt.% and most preferably not more than 20 wt.% of an anionic surfactant based on the weight of the detergent composition.

The additional anionic surfactant is preferably alkyl sulphate, alkyl ether sulphate or combinations thereof. Still preferably the solid laundry composition according to the present invention includes from 0.1 wt.% to 20 wt.% of the alkyl ether sulphate or alkyl ether carboxylate surfactant and preferably 1 wt.% to 20 wt.% of alkyl sulphate surfactants. Preferably the alkyl ether sulphate surfactant has an average EO group ranging from 1 to 10, still preferably 1 to 7 and most preferably 1 to 3.

Nonionic surfactants for use in the invention are typically polyoxyalkylene compounds, i.e. the reaction product of alkylene oxides (such as ethylene oxide or propylene oxide or mixtures thereof) with starter molecules having a hydrophobic group and a reactive hydrogen atom which is reactive with the alkylene oxide. Such starter molecules include alcohols, acids, amides or alkyl phenols. Where the starter molecule is an alcohol, the reaction product is known as an alcohol alkoxylate. The polyoxyalkylene compounds can have a variety of block and heteric (random) structures. For example, they can comprise a single block of alkylene oxide, or they can be diblock alkoxylates or triblock alkoxylates. Within the block structures, the blocks can be all ethylene oxide or all propylene oxide, or the blocks can contain a heteric mixture of alkylene oxides. Examples of such materials include C_8 to C_{22} alkyl phenol ethoxylates with an average of from 5 to 25 moles of ethylene oxide per mole of alkyl phenol; and aliphatic alcohol ethoxylates such as C_8 to C_{18} primary or secondary linear or branched alcohol ethoxylates with an average of from 2 to 40 moles of ethylene oxide per mole of alcohol.

A preferred class of nonionic surfactant for use in the invention includes aliphatic C_8 to C_{18}, more preferably C_{12} to C_{15} primary linear alcohol ethoxylates with an average of from 3 to 20, more preferably from 5 to 10 moles of ethylene oxide per mole of alcohol.

A further class of surfactants include the alkyl poly glycosides and rhamnolipids.

Mixtures of any of the above-described nonionic surfactant may also be used. Preferably the composition includes from 0 to 10 wt.%, still preferably from 0 to 5 wt.% nonionic surfactant.

Preferably the laundry detergent composition includes a combination of LAS along with non-ionic surfactant and still preferably LAS, nonionic surfactant and additional anionic surfactant selected from alkyl ether sulphate, alkyl sulphate surfactants.

Builders:

The solid laundry composition preferably includes a builder. The term "builder" as used herein means all materials which tend to remove polyvalent metal ions (usually calcium and/or magnesium) from a solution either by ion exchange, or complexation and/or sequestration, or suspension or precipitation. The builder is preferably a precipitation builder.

Disclosed detergent composition includes from 1 wt.% to 40 wt.% carbonate builders. The carbonate builder is an alkali metal carbonates, bicarbonate, sesquicarbonate or mixtures thereof. The carbonate builder is preferably an alkali metal carbonate. Preferred alkali carbonates are sodium and/or potassium carbonate of which sodium carbonate is particularly preferred. It is further preferred that sodium carbonate makes up at least 75 wt.%, more preferably at least 85 wt.% and even more preferably at least 90 wt.% of the total weight of the carbonate salt.

Preferably the detergent composition comprises at least 0.8 wt.%, still preferably at least 1 wt.%, still preferably at least 2 wt.%, most preferably at least 5 wt.% of the carbonate salt, but typically not more than 15 wt.%, still preferably not more than 13 wt.%, most preferably not more than 10 wt.% of carbonate builder based on the weight of the detergent composition.

In addition to the carbonate builder the laundry composition of the present invention may preferably include a further non-carbonate inorganic salt. The preferred inorganic non-carbonate salts may be selected from the group consisting of silicates, silica, zeolites, phosphates or mixtures thereof.

Suitable silicates include the water-soluble sodium silicates with an SiO_2: Na_2O ratio of from 1.0 to 2.8, with ratios of from 1.6 to 2.4 being preferred, and 2.0 ratio being most preferred. The silicates may be in the form of either the anhydrous salt or a hydrated salt. Sodium silicate with an SiO_2: Na_2O ratio of 2.0 is the most preferred silicate.

Yet other non-carbonate builder may be organic builders which includes but are not limited to as succinates, carboxylates, malonates, polycarboxylates, citric acid or a salt thereof.

Preferably the composition of the present invention is substantially free of zeolite salt and phosphate builder. By substantially free it is meant that there is no deliberately added phosphate or zeolite in the composition.

Inorganic compounds:

The composition preferably includes inorganic compound which is preferably a calcium-based compound, more preferably the calcium-based compound is selected from calcium carbonate, calcium magnesium carbonate, calcite, dolomite or mixtures thereof. Other preferred inorganic compound in the laundry composition includes magnesium and aluminium silicates, calcium and magnesium oxides. Preferably the laundry composition includes calcite commercially available as Forcal™ U.

Polymers:

The laundry composition of the present invention may preferably include polymers which provide cleaning or care benefits. The cleaning polymer includes but is not limited to soil release polymer, carboxylate polymers, antiredeposition polymers, cellulosic polymers, care polymers, amphiphilic alkoxylated grease cleaning polymers, clay soil cleaning polymers, soil suspending polymers or mixtures thereof.

Anti-redeposition polymers are designed to suspend or disperse soil. Typically, antiredeposition polymers are polyethylene glycol polymers, polycarboxylate polymers, polyethyleneimine polymers or mixtures thereof. Such polymers are available from BASF under the trade name Sokalan®CP5 (neutralised form) and Sokalan®CP45 (acidic form).

Soil release polymers are designed to modify the surface of the fabric to facilitate the ease of removal of soil. Suitable soil release polymers are sold by Clariant under the TexCare® series of polymers, e.g. TexCare® SRN240, TexCare® SRN100, TexCare® SRN170, TexCare® SRN300, TexCare® SRN325, TexCare® SRA100 and TexCare® SRA300. Other suitable soil release polymers are sold by Rhodia under the Repel-o-Tex® series of polymers, e.g. Repel-o-Tex® SF2, Repel-o-Tex® SRP6 and Repel-o-Tex® Crystal. A preferred polymer is selected from the group consisting of polyester soil release polymer, both end-capped and non-end-capped sulphonated PET/POET polymers, both end-capped and non-end-capped unsulphonated PET/POET polymers or combinations thereof.

Sequestrant:
The laundry compositions may also preferably comprise a sequestrant component. Examples include the alkali metal citrates, succinates, malonates, carboxymethyl succinates, carboxylates, polycarboxylates and polyacetyl carboxylates. Specific examples include sodium, potassium and lithium salts of oxydisuccinic acid, mellitic acid, benzene polycarboxylic acids, and citric acid. Other examples are DEQUEST™, organic phosphonate type sequestering agents sold by Monsanto and alkanehydroxy phosphonates.

Preferably the sequestrants includes Dequest(R) 2066 (Diethylenetriamine penta(methylene phosphonic acid or Heptasodium DTPMP), HEDP (1 -hydroxyethylidene -1,1,-diphosphonic acid) or combinations thereof.

Shading dyes or hueing agent:
Shading dye can be used to improve the performance of the compositions. Preferred dyes are violet or blue. It is believed that the deposition on fabrics of a low level of a dye of these shades, masks yellowing of fabrics. A further advantage of shading dyes is that they can be used to mask any yellow tint in the composition itself. Shading dyes are well known in the art of laundry solid formulation.

Suitable and preferred classes of dyes include direct dyes, acid dyes, hydrophobic dyes, basic dyes, reactive dyes and dye conjugates. Preferred examples are Disperse Violet 28, Direct violet 9, Direct violet 66, Direct violet 99, Solvent 13, Acid Violet 50, anthraquinone dyes covalently bound to ethoxylate or propoxylated polyethylene imine as described in WO2011/047987 and WO2012/119859 alkoxylated mono-azo thiophenes and any combinations thereof.

The shading dye is preferably present is present in the composition in range from 0.0001 to 0.1wt %. Depending upon the nature of the shading dye there are preferred ranges depending upon the efficacy of the shading dye which is dependent on class and particular efficacy within any particular class.

Optical brighteners:

It may be advantageous to include fluorescer in the compositions. Usually, these fluorescent agents are supplied and used in the form of their alkali metal salts, for example, the sodium salts. The total amount of the fluorescent agent or agents used in the composition is generally from 0.005 to 2 wt %, more preferably 0.01 to 0.5 wt % the composition.

Preferred classes of fluorescer are: Di-styryl biphenyl compounds, e.g. Tinopal ® CBS-X, Di-amine stilbene di-sulphonic acid compounds, e.g. Tinopal DMS pure Xtra, Tinopal 5BMGX, and Blankophor ® HRH, and Pyrazoline compounds, e.g. Blankophor SN.

Preferred fluorescers are: sodium 2 (4-styryl-3-sulfophenyl)-2H-napthol[1,2-d]triazole, disodium 4,4'-bis{[(4-anilino-6-(N methyl-N-2 hydroxyethyl) amino 1,3,5-triazin-2-yl)]amino}stilbene-2-2' disulfonate, disodium 4,4'-bis{[(4-anilino-6-morpholino-1,3,5-triazin-2-yl)]amino} stilbene-2-2' disulfonate, and disodium 4,4'-bis(2-sulfoslyryl)biphenyl. Most preferably the fluoescer is a di-styryl biphenyl compound, preferably sodium 2,2'-([1,1'-biphenyl]-4,4'-diylbis(ethene-2,1-diyl))dibenzenesulfonate (CAS-No 27344-41-8).

Preferably the composition is substantially free of optical brighteners and fluorescers. Preferably the composition has 0 wt.% optical brighteners and fluorescers.

Bleach and Bleach activators:

It may be advantageous to include bleach in the compositions. The bleach includes sodium percarbonate or any other hydrogen peroxide precursor. The bleach is preferably a peroxide. Most preferably, the bleach is a percarbonate. Further preferred, the bleach is a coated percarbonate. If present, preferred amounts of bleach are from 1.0 to 25 wt.%, more preferably at from 2.0 to 20 wt. %, even more preferably from 5 to 15 wt.%. The composition preferably also includes a bleach activator such as peroxyacid bleach precursors. The bleach activators include sodium tetraacetylethylenediamine (TAED). The composition may include an acyl hydrazine bleach catalyst.

Visual Cues:

Advantageously the laundry composition includes visual cues. The compositions may comprise visual cues of solid material that is not dissolved in the composition. Preferred visual cues are lamellar cues formed from polymer film and possibly comprising functional ingredients. Enzymes and bleach catalysts are examples of such ingredients. Also perfume, particularly microencapsulated perfume may be included in visual cues. Visual cues generally are of a color contrasting to the colour of the remaining laundry composition.

Perfume:

Perfume is well known in the art and are preferably incorporated into laundry compositions described herein at level of 0.1 wt.% to 5 wt%. The perfume may be selected from encapsulated perfume, microcapsules, perfume oil or mixtures thereof.

Enzymes:

Preferably the solid laundry composition includes an effective amount of one or more enzyme selected from the group comprising, protease, amylase, cellulase, lipase, mannanase and mixtures thereof. The enzymes are preferably present with corresponding enzyme stabilizers. Commercially available enzymes from Novozyme and Dupont are preferred.

Fillers

A solid laundry composition may also include one or more fillers to assist in providing the desired density and bulk to the composition. Suitable fillers for use in the invention may generally be selected from neutral salts with a solubility in water of at least 1 gram per 100 grams of water at 20°C; such as alkali metal, alkaline earth metal, ammonium or substituted ammonium chlorides, fluorides, acetates and sulfates and mixtures thereof. Preferred fillers for use in the invention include alkali metal (more preferably sodium and/or potassium) sulfates and chlorides and mixtures thereof, with sodium sulfate and/or sodium chloride being most preferred.

Filler, when included, may be present in a total amount ranging from about 1 to about 80%, preferably from about 5 to about 50% (by weight based on the total weight of the composition).

Water content:

Preferably the solid laundry composition includes from 0.1 wt.% to 4.5 wt.% water, still preferably from 0.1 wt.% to 3.5 wt.% water.

pH:

The laundry composition of the present invention may have a pH at 1% in deionized water of greater than about 6, alternatively greater than 7.

A solid laundry composition according to the present disclosure also encompasses a variety of unit dose composition which may include cast and extruded forms including, for example, solids, pellets, blocks, bars, and tablets, particulate or powder composition enclosed within a water soluble pouch, detergent contained on or in a porous substrate or nonwoven sheet, and other suitable forms that may be apparent to one skilled in the art in view of the teachings herein. The solid unit dose composition composition according to the present invention preferably has a pH from 7.0 to 13, preferably 7.0 to 10.5, still preferably 7.0 to 10.2, still further preferably from 8.5 to 10.2, when measured at 1 wt.% dilution in de-ionised water at 25°C. The composition may preferably include a buffer.

The unit dose composition according to the present invention may be made via a variety of conventional methods known in the art and includes but is not limited to the mixing of ingredients, including dry-mixing, followed by compaction such as agglomerating, extrusion, tabletting. The unit dose composition enclosed within a water soluble pouch may be in the particulate or powder form and where such detergent composition may be made by any of the conventional processes, especially preferred is the technique of slurry making and spray drying or the non-tower route.

A preferred unit dose composition includes an extruded laundry composition which includes an amount of laundry composition which is sufficient for one laundry wash.

Another preferred unit dose laundry composition includes a tablet. The tablet is preferably formed using known tableting process known to a person skilled in the art. The tablet may be formulated using a single composition. Alternately, specific region of the tablet may have different composition. The tablet may preferably be coated and have a core with a different composition and a coating with a different composition. Preferably the entire tablet may dissolve at the same time. Alternately, specific region of the tablet may dissolve at different stages of the wash cycle. The tablet may dissolve sequentially triggered by specific external response which included but is not limited to temperature, pressure or pH of the wash liquor. On the other hand, the sequential release may be determined by the varying levels of disintegration ingredient present in different regions. Non-limiting examples of the disintegrant includes those selected from swellable agent, preferably a polymer material. Non-limiting examples includes starch, cellulose and derivatives thereof, alginates, sugars, polysaccharides, polyvinylpyrrolidones, swellable clays and mixtures thereof. Water-swellable polymer material include for example, synthetic polymers such as polyvinylpyrrolidone (PVP) or natural polymers and/or modified natural substances such as polysaccharides, cellulose, microcrystalline cellulose, starch and their derivatives or alginates or casein derivatives. Another example of the disintegrant integrant is an effervescent disintegrant agent which are substances that can create a pressure through the release of gases, non-limiting example include carbonate/citric acid systems. The effervescent agent as used herein includes ingredient which release gas in-situ. Preferred effervescent systems, however, consist of at least two components which react with one another to form a gas in-situ. Preferably the components of the effervescent system include an alkali salt component which reacts with an acidifying agent to release carbon dioxide in-situ. For example, the alkaline salt component include alkali metal carbonate and/or bicarbonate. A preferred example of an acidifying agent which releases carbon dioxide from a reaction with the alkali salts in aqueous solution is citric acid. Preferably the acidifying agent used as a component of the effervescent disintegrant agent include weak acids, for example, polycarboxylic acids, citric acid (preferred), malic acid, maleic acid, malonic acid, itaconic acid, oxalic acid, glutaric acid, glutamic acid, lactic acid, fumaric acid, glycolic acid, tartaric acid and mixtures thereof. Suitable acids include mono, di, or tri basic acids having pKa in the range of 1 to 6.9. Preferably acids include amino sulphonic acids, organo phosphonic acids, HEDP acid, polycarboxylic acids or mixtures thereof.

The unit-dose laundry composition may be preferably packaged in a unit dose pouch. The unit dose pouch is preferably made of a water-soluble film material, such as a polyvinyl alcohol. Preferably the unit dose pouch includes a single or multi-compartment pouch enclosing a laundry composition. The laundry composition may be a solid laundry composition, or at least one compartment may hold a solid laundry composition. Examples of suitable pouches and water-soluble film materials are provided in U.S. Patent Nos. 6,881,713, 6,815,410., and 7,125,828.

Preferably the laundry unit-dose composition may be in the form of an article where the article may comprise a solid laundry composition as described herein and a substrate, wherein the composition may be in contact with the substrate. Preferably the substrate may be fully or partially in the form of a film. Preferably the film may have a thickness ranging from 0.01 mm to 5.0 mm, or from 0.1 mm to 2.5 mm, or from 0.3 mm to 1.5 mm, more preferably from 0.5 mm to 1.0 mm. Also preferred is wherein the composition is present in the article in the form of a layer having a thickness as measured from the surface of the composition in contact with the substrate to the outer surface of the composition ranging from 0.01 mm to 0.3 mm, or from 0.020 mm to 0.2 mm, or from 0.025 mm to 0.1 mm, more preferably from 0.03 mm to 0.05 mm.

The substrate may be selected from the group consisting of water-soluble substrates, water-insoluble substrates, water dispersible substrates, water disintegrating substrates, and combinations thereof. Suitable water-soluble substrates include polyvinyl alcohol (PVA), polyvinyl pyrrolidone, cellulose, cellulose ethers, cellulose esters, polycarboxylic acids and salts, polyaminoacids or peptides, polyamides, polyacrylamide, copolymers of maleic/acrylic acids, polyvinyl alcohol copolymers, hydroxypropyl methyl cellulose (HPMC), or mixtures thereof. The water-soluble substrate may comprise a water-soluble substrate selected from the group consisting of cold-water soluble substrates, hot-water soluble substrates, and mixtures thereof.

Suitable non-limiting example of a water-insoluble substrate includes natural polymer in the form of woven or non-woven matrix selected from cellulose, chitosan, starch, seed hulls, derivatives thereof, and combinations thereof. Non-limiting example of a dispersible substrate includes paper.

Preferably the unit-dose laundry composition is a water-soluble pouch having a compartment enclosing a solid laundry composition. Preferably the solid laundry composition is prepared by a spray-drying process. The spray-drying is carried out using any of the conventional spray drying system known in the art.

EXAMPLES

Example 1

In table 1 below, provided are two unit dose laundry liquid formulations which comprises LAS obtained from plastic feedstock comprising 5% wt. of the total LAS present and having enzyme. The remaining LAS is obtained from petroleum feedstock.

Table 1: Liquid laundry composition

Ingredient	Weight %	
Alcohol ethoxylate	20.0	26.9
Glycerol	14.2	16.3
Fatty Acid	13.9	6.9
LAS	13.8	13.8
Mono propylene glycol	11.6	11.6
Monoethanolamine	6.9	4.9
enzymes	5.2	5.2
perfume	4.4	4.4
Polyester cleaning polymer	4.3	4.3
Dequest 2066	2.8	2.8
cleaning polymer	2.0	2.0
potassium sulphite	0.4	0.4
TinoPal CBS-CL	0.3	0.3
water	0.2	0.2

Example 2

In table 2 below are provided 2 different spray-dried solid laundry detergent composition (Ex 1 and Ex 2) according to the present invention were prepared having LAS obtained from plastic waste feedstock at an amount which constituted 5 wt.% of the total LAS present and having a combination of enzyme. The remaining LAS is obtained from petroleum feedstock.

Table 2: Spray-dried solid laundry composition

	Ex 1	Ex 2
Na LAS	15	19
PAS	0	0
SLES	0	1
Sodium carbonate	13	14
Sodium silicate	7.0	10
Layering agent (calcite)	6.5	4.5
Visual cues	0.5	0.5
Moisture	2.19	2.5
Perfume	0.36	0.4
Carboxylate polymer	0.50	0.5
Antiredeposition agent	0	0.2
Antifoam	2	2
Shading dye	0	1.1
Optical brightener (Tinopal)	0.2	0
Enzyme (protease, amylase, lipase, mannanase)	0.2	0.5
NDOM	0.5	0.5
Water	2.0	2.6
Sodium sulphate	Upto 100	Upto 100

Example 3

The surface tension of the LAS obtained from waste plastic feedstock and the LAS obtained from petroleum feedstock were evaluated and the results recorded are provided in table 3 below.

Table 3

Ex A		**Ex B**		**Ex C**		**Ex D**	
Conc [mg/l]	Avg. SFT [mN/m]	Conc [mg/l]	Avg. SFT [mN/m]	Conc [mg/l]	Avg. SFT [mN/m]	Conc [mg/l]	Avg. SFT [mN/m]
2500.00	33.05	2500.00	30.45	1500.00	33.20	1500.00	33.22
2244.47	33.25	2244.47	30.50	1344.45	33.71	1400.01	33.39
1988.89	33.41	1988.89	30.87	1188.88	33.96	1300.00	33.73
1733.32	33.50	1733.32	31.10	1033.34	34.12	1200.01	34.11
1477.77	33.68	1477.77	31.41	877.78	34.30	1099.99	34.32
1222.23	33.95	1222.23	32.03	722.23	34.48	999.99	34.52
966.67	34.35	966.67	32.73	566.66	35.60	900.00	34.69
711.11	35.16	711.11	33.65	411.11	37.69	800.00	34.98
455.56	36.24	455.56	34.65	255.55	40.81	700.01	35.31
200.00	36.99	200.00	35.37	100.00	43.62	600.00	36.30
						500.00	38.03
						400.00	39.94
						300.00	42.11
						200.00	44.18
						100.00	46.02

The data shows that LAS obtained from waste plastic feedstock (Ex A and Ex B) has a much lower surface tension at lower concentrations. This means that the surface tension changes during the wash cycle more for LAS obtained from petroleum source than for LAS obtained from waste-plastic feedstock. This means that LAS obtained from waste-plastic feedstock (Ex A and Ex B) performs better than LAS obtained from petroleum feedstock (Ex C and Ex D) during the wash.

CLAIMS

1. A laundry composition comprising linear alkyl benzene sulphonate (LAS) obtained from waste plastic feedstock, LAS obtained from petroleum feedstock and an enzyme.

2. A composition according to any claim 1 wherein the LAS obtained from waste plastic feedstock comprises from 0.001 wt.% to 8% wt. of the total LAS.

3. A composition according to any preceding claim wherein the LAS comprises an alkyl component obtained from a renewable source, more preferably from a plant, algae or yeast.

4. A composition according to any one of the preceding claims, wherein linear alkyl benzene sulphonate comprises from 50 wt.% to 100 wt.% of the total surfactant content present in the composition.

5. A composition according to any one of the preceding claims wherein the LAS obtained from waste plastic feedstock comprises a benzene moiety obtained from waste plastic feedstock and an alkyl group obtained from a petroleum feedstock.

6. A composition according to any one of the preceding claims wherein the LAS obtained from waste plastic feedstock comprises a benzene moiety obtained from waste plastic feedstock and an alkyl group obtained from a plant-based feedstock.

7. A composition according to any preceding claim wherein the LAS obtained from waste plastic feedstock comprises a benzene moiety obtained from waste plastic feedstock and an alkyl group obtained from waste plastic feedstock.

8. A composition according to any one of the preceding claims wherein the enzyme is selected from the group consisting of amylase, lipase, mannanase, cellulase, protease, laccase, pectate lyase or mixtures thereof.

9. A composition according to any one of the preceding claims wherein the composition comprises an enzyme stabilizer.

10. A composition according to any one of the preceding claims wherein the LAS obtained from waste plastic feedstock comprises an alkyl chain with an average alkyl chain length ranging from 8 to 14 carbon atoms, preferably from 10 to 14 carbon atoms.

11. A composition according to any one of the preceding claims wherein at least 30 wt.% of the LAS obtained from waste plastic feedstock comprises alkyl chain with 12 carbons.

12. A composition according to any preceding claim wherein from 1 wt.% to 30 wt.% of the LAS obtained from waste plastic feedstock comprises 2-phenyl isomer.

13. A composition according to any one of the preceding claims which is a solid laundry composition.

14. A composition according to claim 1 to 13 which is a liquid laundry composition.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2022/077434

A. CLASSIFICATION OF SUBJECT MATTER
INV. C11D1/22 C11D11/00 C11D3/386
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C11D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 3 613 835 A1 (PROCTER & GAMBLE [US]) 26 February 2020 (2020-02-26) claim 12 paragraph [0009]; claim 15 paragraph [0045] paragraphs [0055], [0082] paragraph [0025]; claim 16 the whole document -----	1-14
X	EP 3 334 804 B1 (PROCTER & GAMBLE [US]) 20 January 2021 (2021-01-20)	1-14
Y	paragraphs [0100], [0106] - [0108]; example 2 paragraphs [0006] - [0072] paragraphs [0074] - [0079] paragraphs [0069] - [0073] the whole document -----	1-14
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2022/077434

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2021/099095 A1 (UNILEVER IP HOLDINGS B V [NL]; UNILEVER GLOBAL IP LTD [GB] ET AL.) 27 May 2021 (2021-05-27) claim 1 page 21, lines 1-4 page 35, line 13 - line 24 -----	1-14

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2022/077434

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