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## (54) LAUNDRY DETERGENT COMPOSITION

(57) The present invention relates to a coated detergent particle having a distorted oblate spheroidal shape with perpendicular dimensions x, y and z, wherein x is from 1 to 2 mm, y is from 2 to 8mm, and z is from 2 to 8 mm, wherein the particle comprises:
(a) from 20wt% to 59wt% detersive surfactant selected from anionic detersive surfactant and/or non-ionic detersive surfactant;
(b) from 10wt% to 40wt% inorganic salts selected from sodium carbonate, sodium sesquicarbonate, sodium bicarbonate and any mixtures thereof;
(c) optionally, from 10wt% to 40wt% citric acid and/or salts thereof;
wherein the detersive surfactant comprises from 51wt% to 100wt% alkyl benzene sulphonate,
wherein the coating comprises the inorganic salt (b), and wherein the core comprises the detersive surfactant (a),
wherein the oblate spheroidal shape is distorted such that the ratio of the surface area (S) to volume (V) of the particle is different to the value of NL,

$$S / V \neq NL$$

wherein NL is defined as:

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$$NL = \frac{3}{2b} + \frac{3b}{4\epsilon a^2} ln\left(\frac{1+\epsilon}{1-\epsilon}\right)$$

wherein a = is half of the greater of y or z (long radius of the oblate)
b = half of the dimension x (short radius of the oblate)
$\in$ = the eccentricity,
wherein

$$\epsilon = \sqrt{1 - \frac{b^2}{a^2}}$$

## Description

FIELD OF THE INVENTION

**[0001]** The present invention relates to a laundry detergent composition having a distorted lenticular size and shape. The lenticular laundry detergent compositions of the present invention exhibit good flowability profiles.

BACKGROUND OF THE INVENTION

**[0002]** There is a recent trend in the field of laundry detergency to develop compositions that are in the form of lenticles. In addition, there is a recent trend, in the field of laundry detergent particles, to seek to package these particles in a bottle instead of a box. These solid particles are of a shape and size that exhibit different product performance characteristics compared to conventional particulate detergent products such as the laundry powders currently sold in boxes. For example, the flowability of such particles, from a laundry box or even from a bottle, can be very different.

**[0003]** There is a need to control the flowability profile of the particles. The present invention seeks to provide a lenticular laundry detergent product having a flowability profile that enables a good control of product dispensing, especially from a bottle.

**[0004]** The inventors have found that by distorting the oblate spheroid shape of the lenticular detergent particle, the flowability of such particles can be altered so as to enable a higher level of control of dosing, especially when pouring the particles from a bottle container.

**[0005]** The altered flowability of these distorted shapes results in a slower, but still acceptably consistent, flow rate out of a container. This slower but still consistent flow rate allows for a more controlled dispensing profile when pouring the particles out of a container, for example a bottle.

SUMMARY OF THE INVENTION

**[0006]** The present invention provides a coated detergent particle having a distorted oblate spheroidal shape with perpendicular dimensions x, y and z, wherein x is from 1 to 2 mm, y is from 2 to 8mm, and z is from 2 to 8 mm, wherein the particle comprises:

(a) from 20wt% to 59wt% detersive surfactant selected from anionic detersive surfactant and/or non-ionic detersive surfactant;
(b) from 10wt% to 40wt% inorganic salts selected from sodium carbonate, sodium sesquicarbonate, sodium bicarbonate and any mixtures thereof;
(c) optionally, from 10wt% to 40wt% citric acid and/or salts thereof;

wherein the detersive surfactant comprises from 51wt% to 100wt% alkyl benzene sulphonate,
wherein the coating comprises the inorganic salt (b), and wherein the core comprises the detersive surfactant (a),
wherein the oblate spheroidal shape is distorted such that the ratio of the surface area (S) to volume (V) of the particle is different to the value of NL,

$$S / V \neq NL$$

wherein NL is defined as:

$$NL = \frac{3}{2b} + \frac{3b}{4\epsilon a^2} ln\left(\frac{1+\epsilon}{1-\epsilon}\right)$$

wherein a = is half of the greater of y or z (long radius of the oblate)
b = half of the dimension x (short radius of the oblate)
$\varepsilon$ = the eccentricity,

wherein

$$\epsilon = \sqrt{1 - \frac{b^2}{a^2}}$$

DETAILED DESCRIPTION OF THE INVENTION

**[0007]** The coated detergent particle: The coated detergent particle has perpendicular dimensions x, y and z, wherein x is from 1 to 2 mm, y is from 2 to 8mm, and z is from 2 to 8 mm, wherein the particle comprises:

(a) from 20wt% to 59wt% detersive surfactant selected from anionic detersive surfactant and/or non-ionic detersive surfactant;
(b) from 10wt% to 40wt% inorganic salts selected from sodium carbonate, sodium sesquicarbonate, sodium bicarbonate and any mixtures thereof;
(c) optionally, from 10wt% to 40wt% citric acid and/or salts thereof;

wherein the detersive surfactant comprises from 51wt% to 100wt% alkyl benzene sulphonate,
wherein the coating comprises the inorganic salt (b), and wherein the core comprises the detersive surfactant (a),
wherein the oblate spheroidal shape is distorted such that the ratio of the surface area (S) to volume (V) of the particle is different to the value of NL,

$$S / V \neq NL$$

wherein NL is defined as:

$$NL = \frac{3}{2b} + \frac{3b}{4\epsilon a^2} ln\left(\frac{1+\epsilon}{1-\epsilon}\right)$$

wherein a = is half of the greater of y or z (long radius of the oblate)
b = half of the dimension x (short radius of the oblate)
$\varepsilon$ = the eccentricity,

wherein

$$\epsilon = \sqrt{1 - \frac{b^2}{a^2}}$$

**[0008]** The degree of distortion of the particles from an oblate spheroid form can be altered by changing the process conditions under which the particles are made. Typically such extrudates are made by extruding material through a twin-screw extruder equipped with a die-plate (with orifices) and a rotational cutter. Suitable extruders are the MPX series from Baker Perkins. The maximum y and z dimensions of the particle can be varied by altering dimensions of the orifice through which the extruded material is passed. The degree of distortion is most easily altered by changing the rate at which the material is extruded through the orifice of an extruder and the frequency of cutting. Decreasing the frequency at which a rotary cutter tool passes the front of the orifices in the die-plate will increase the degree of distortion and hence reduce the surface area to volume ratio. Increasing the speed at which material passes through an orifice prior to cutting can also be used to increase the degree of distortion and reduce the surface area to volume ratio due to the increased "springback" that will happen at higher extrusion velocities. The S/V ratio may be increased by increasing the rotational speed of cutting and increasing the degree of hardness of the extrusion mix.

**[0009]** Preferably, the oblate spheroidal shape is distorted such that the greatest of the ratio of the surface area (S) to volume (V) of half the particle in the y-z plane is different to the value of NL.

**[0010]** Typically, the oblate spheroidal shape of the particle is distorted such that at the radius equal to the linear eccentricity (c), the greatest of the half height of the particle (h) in the x-plane is greater than the semi latus rectum (*p*),

$$h > p$$

wherein

$$p = \frac{b^2}{a}$$

$$c = \sqrt{a^2 - b^2}$$

**[0011]** The oblate spheroidal shape of the particle may be distorted such that at the radius equal to the linear eccentricity (c), the greatest of the half height of the particle (h) in the x-plane is greater than the lactus rectum (*p*) multiplied by 1.05,

$$h > p \text{ x } 1.05.$$

**[0012]** The oblate spheroidal shape of the particle may be distorted such that the ratio of the surface area (S) to volume (V) of the particle is less than NL multiplied by 0.99,

$$S / V < NL \text{ x } 0.99.$$

**[0013]** The volume ratio of the particle is typically above 1, where volume ratio is defined as the ratio of (i) the greater volume of the particle to one size of the y-z plane to (ii) the lesser volume of the particle to the other side of the y-z plane

**[0014]** The coated detergent particle is also referred to herein as the composition.

**[0015]** Typically, at 1wt% dilution in de-ionised water at 20°C, the composition has a pH in the range of from 7.6 to 10.0.

**[0016]** Typically, at 1wt% dilution in de-ionised water at 20°C, the composition has a reserve alkalinity to pH 7.5 of greater than 3.0.

**[0017]** Typically, the composition is in the form of a coated laundry detergent particle that is curved.

**[0018]** Typically, the coating comprises the inorganic salt (b), and wherein the core comprises the detersive surfactant (a).

**[0019]** The coated laundry detergent particle may be lenticular (e.g. shaped like a whole dried lentil), a distorted oblate ellipsoid, and where z and y are the equatorial diameters and x is the polar diameter; preferably y = z.

**[0020]** The dimensions of the particles, including x, y and z dimension, and the S and V values, and the height of the particle at the the radius equal to the linear eccentricity, can be determined by use of X-Ray Tomography techniques (referred to as micro-CT). A suitable instrument for analyzing the 3-dimensional shape of the particles is the GE Phoenix v tome x micro-CT scanner (from GE Sensing & Inspection Technologies GmbH Niels-Bohr-Str.7 31515 Wunstorf, Germany). Samples for analysis can be positioned on the equipment plate with a diameter of 35 mm. This can then be mounted within a plastic tube sample holder of diameter 36 mm which can be fixed on a rotational stage (integrated within the machine chamber) and scanned with the following image acquisition parameters: voltage:80 kV; current: 200 μA; tube mode: 0; timing: 500 ms; averaging: 4; skip frames: 1; number of images: 2000. Each reconstructed data set consists of a stack of 2D images, each 2014*2014 pixels, with an isotropic resolution of 19.40 μm.

**[0021]** Thresholding, image analysis, and quantification of particle volumes above and below the y-z plane can be done using appropriate software using the associated procedures, for example VG Studio MAX 3.0 (Volume Graphics GmbH, Germany) and Avizo 9.1.1 (Visualization Services Group / FEI Company, Burlington, Massachusetts, U.S.A.). Suitable analysis can be done as below.

1. The reconstructed micro-CT data is read by the VG studio MAX 3.0 software.
2. The 3D CT data is exported set to 16bit tif image stack using VG Studio MAX 3.0.
3. The 16 bit tif image stack was then read into Avizo 9.1.1.
4. After image import, a median filter of parameter 3 was applied for the image stack to reduce background noise.
5. A thresholding method based on the contrast of the image gray level was used to isolate laundry particles from the background.
6. The volume below and above the y-z plane was calculated for each individual particle using the mathematic modules embedded in Avizo 9.1.1.

**[0022]** Average surface roughness (Ra): Typically, the particle has an average surface roughness (Ra) of less than 6.0μm. Ra (average surface roughness) is a measure to characterize the surface roughness that is commonly adopted in general engineering practice. It provides a description of the height variability in the surface. A mean line is first found that is parallel to the general surface direction and divides the surface in such a way that the sum of the areas formed above the line is equal to the sum of the areas formed bellow the line. The surface roughness RA is now given be the sum of the absolute values of all the areas above and below the mean line divided by the sampling length. Characterization of surface roughness can be done on profilometer instruments as described in WO2010/122050.

**[0023]** Coefficient of friction: For the purpose of present invention, coefficient of friction is the static coefficient of friction. Typically, the particle has a coefficient of friction in the range of from 0.2 to 0.5. A coefficient of friction is typically expressed as the ratio between the surface (tangential) v/s the normal force applied on the contact. This is typically obtained from bulk flow experimental calibrations (such as heap test/angle of repose). A heap is formed by allowing bulk material flow drop under gravity. A slope angle is obtained from these experiments. Simulations are run with different frictional values until the angle of repose is matched. For these simulations, dynamic and static friction is kept the same. Often when non-spherical particles are approximated with the spherical particles, rolling friction model is deployed as well. The value of coefficient of friction typical ranges between 0-1. Where 0 would mean no resistance being offered (very smooth contacts) and 1 would mean a high resistance offered (very rough contacts).

**[0024]** The coated laundry detergent particle may be shaped as a disc. Preferably the coated laundry detergent particle does not have hole; that is to say, the coated laundry detergent particle does not have a conduit that passes through the core: i.e. the coated detergent particle has a topologic genus of zero.

**[0025]** The composition may comprise from 0.05wt% to 4.0wt% soil release polymer.

**[0026]** The composition may comprise from 0.1wt% to 3.0wt% carboxymethylcellulose (CMC).

**[0027]** The composition may comprise from 0.1wt% to 5.0wt% calcite.

**[0028]** The composition may comprise from 1wt% to 10wt% carboxylate polymer.

**[0029]** The composition may comprise less than 10wt% total level of silicates and aluminosilicates.

**[0030]** The composition may comprise from 0.001wt% to 0.5wt% hueing dye.

**[0031]** The composition may comprise from 0.001wt% to 0.5wt% organic pigment and/or inorganic pigment.

**[0032]** The composition may comprise from 0.2 wt% to 10wt% chelant, preferably phosphonate chelant.

**[0033]** The composition preferably comprises from 10wt% to 40wt% sodium carbonate.

**[0034]** The the alkyl benzene sulphonate may have a 2-phenyl isomer content of at least 20wt%, preferably at least 25wt%.

**[0035]** A suitable method for making the detergent particle is described in WO2010/122050.

**[0036]** Detersive surfactant: A suitable detersive surfactant system typically comprises at least 5% alcohol ether carboxylate as a percentage of the total detersive surfactant system.

**[0037]** A suitable detersive surfactant system typically comprises at least 5% alcohol ethoxylate having an average degree of ethoxylation in the range of from 10 to 50 as a percentage of the total detersive surfactant system.

**[0038]** Preferably, the detersive surfactant comprises $C_8$-$C_{24}$ alkyl ethoxylated alcohol having an average degree of ethoxylation of from 20 to 50, and preferably the compositon comprises from 1wt% to 10wt% $C_8$-$C_{24}$ alkyl ethoxylated alcohol having an average degree of ethoxylation of from 20 to 50. A suitable highly ethoxylated alcohol is Lutensol® AO30 from BASF and/or Slovasol® 2430 from Sasol.

**[0039]** Anionic detersive surfactant: Suitable anionic detersive surfactants include sulphonate and sulphate detersive surfactants.

**[0040]** Suitable sulphonate detersive surfactants include methyl ester sulphonates, alpha olefin sulphonates, alkyl benzene sulphonates, especially alkyl benzene sulphonates, preferably $C_{10-13}$ alkyl benzene sulphonate. Suitable alkyl benzene sulphonate (LAS) is obtainable, preferably obtained, by sulphonating commercially available linear alkyl benzene (LAB); suitable LAB includes low 2-phenyl LAB, other suitable LAB include high 2-phenyl LAB, such as those supplied by Sasol under the tradename Hyblene®.

**[0041]** Suitable sulphate detersive surfactants include alkyl sulphate, preferably $C_{8-18}$ alkyl sulphate, or predominantly $C_{12}$ alkyl sulphate.

**[0042]** A preferred sulphate detersive surfactant is alkyl alkoxylated sulphate, preferably alkyl ethoxylated sulphate, preferably a $C_{8-18}$ alkyl alkoxylated sulphate, preferably a $C_{8-18}$ alkyl ethoxylated sulphate, preferably the alkyl alkoxylated sulphate has an average degree of alkoxylation of from 0.5 to 20, preferably from 0.5 to 10, preferably the alkyl alkoxylated sulphate is a $C_{8-18}$ alkyl ethoxylated sulphate having an average degree of ethoxylation of from 0.5 to 10, preferably from 0.5 to 5, more preferably from 0.5 to 3 and most preferably from 0.5 to 1.5.

**[0043]** The alkyl sulphate, alkyl alkoxylated sulphate and alkyl benzene sulphonates may be linear or branched, substituted or un-substituted, and may be derived from petrochemical material or biomaterial.

**[0044]** Other suitable anionic detersive surfactants include alkyl ether carboxylates.

**[0045]** Suitable anionic detersive surfactants may be in salt form, suitable counter-ions include sodium, calcium, magnesium, amino alcohols, and any combination thereof. A preferred counterion is sodium.

**[0046]** Alkyl ether carboxylic acid: A suitable alkyl ether carboxylic acid has the following structure:

$$R\text{-}(OCH_2CH_2)n\text{-}OCH_2\text{-}COOH$$

wherein,

R is selected from saturated and mono-unsaturated $C_{10}$ to $C_{26}$ linear or branched alkyl chains, preferably $C_{12}$ to $C_{24}$ linear or branched alkyl chains, most preferably a $C_{16}$ to $C_{20}$ linear alkyl chain;

n is selected from 5 to 20, preferably 7 to 13, more preferably 8 to 12, most preferably 9.5 to 10.5; and

The alkyl ether carboxylic acid may be present from 0.5 to 20 wt%, preferably from 2 to 14 wt%, most preferably from 2.5 to 5 wt%. It may be present in acid or salt form, most preferably as its sodium salt.

**[0047]** Suitable materials are sold under the AKYPO® (Kao) and Empicol® C (Huntsman) brand names.

**[0048]** Non-ionic detersive surfactant: Suitable non-ionic detersive surfactants are selected from the group consisting of: $C_8$-$C_{18}$ alkyl ethoxylates, such as, NEODOL® non-ionic surfactants from Shell; $C_6$-$C_{12}$ alkyl phenol alkoxylates wherein preferably the alkoxylate units are ethyleneoxy units, propyleneoxy units or a mixture thereof; $C_{12}$-$C_{18}$ alcohol and $C_6$-$C_{12}$ alkyl phenol condensates with ethylene oxide/propylene oxide block polymers such as Pluronic® from BASF; alkylpolysaccharides, preferably alkylpolyglycosides; methyl ester ethoxylates; polyhydroxy fatty acid amides; ether capped poly(oxyalkylated) alcohol surfactants; and mixtures thereof.

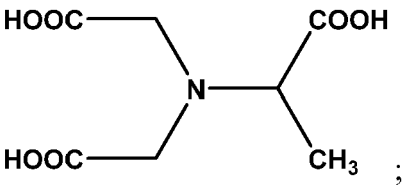
**[0049]** Suitable non-ionic detersive surfactants are alkylpolyglucoside and/or an alkyl alkoxylated alcohol.

**[0050]** Suitable non-ionic detersive surfactants include alkyl alkoxylated alcohols, preferably $C_{8-18}$ alkyl alkoxylated alcohol, preferably a $C_{8-18}$ alkyl ethoxylated alcohol, preferably the alkyl alkoxylated alcohol has an average degree of alkoxylation of from 1 to 50, preferably from 1 to 30, or from 1 to 20, or from 1 to 10, preferably the alkyl alkoxylated alcohol is a $C_{8-18}$ alkyl ethoxylated alcohol having an average degree of ethoxylation of from 1 to 10, preferably from 1 to 7, more preferably from 1 to 5 and most preferably from 3 to 7. The alkyl alkoxylated alcohol can be linear or branched, and substituted or un-substituted.

**[0051]** Suitable nonionic detersive surfactants include secondary alcohol-based detersive surfactants.

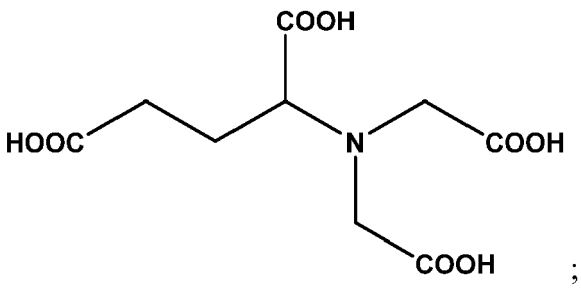
**[0052]** Amino acid derivative complexing agent: A suitable amino acid derivative complexing agent is selected from one or more of the following, in any stereoisomer or mixture of stereoisomer form:

(i) methylglycinediacetic acid and salts thereof (MGDA)




;

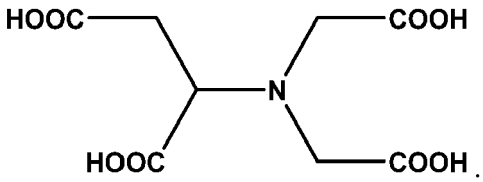
(ii) L-glutamic acid, N,N-diacetic acid and salts thereof (GLDA)



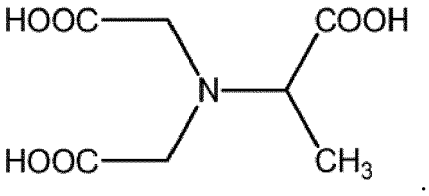

;

and

(iii) L-aspartic acid N,N-diacetic acid and salts thereof (ASDA)



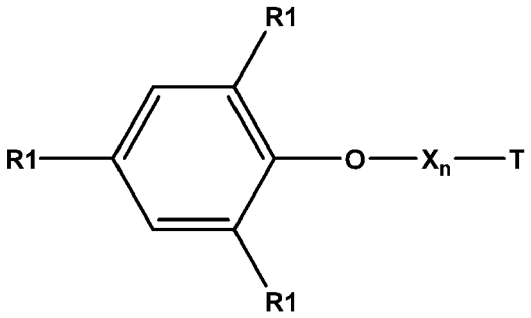

**[0053]** Preferbly, the composition comprises from 0.1wt% to 10wt% methylglycinediacetic acid and salts thereof (MGDA)




**[0054]** It may be preferred to formulate the amino acid derivative complexing agent in acid form. Alternatively, it may be preferred to formulate the amino acid derivative complexing agent in salt form, especially preferred is the sodium salt form.

**[0055]** Suitable MGDA salts are produced by BASF. Suitable GLDA salts are produced by Akzo Nobel and Showa Denko. Suitable ASDA salts are produced by Mitsubishi Rayon.

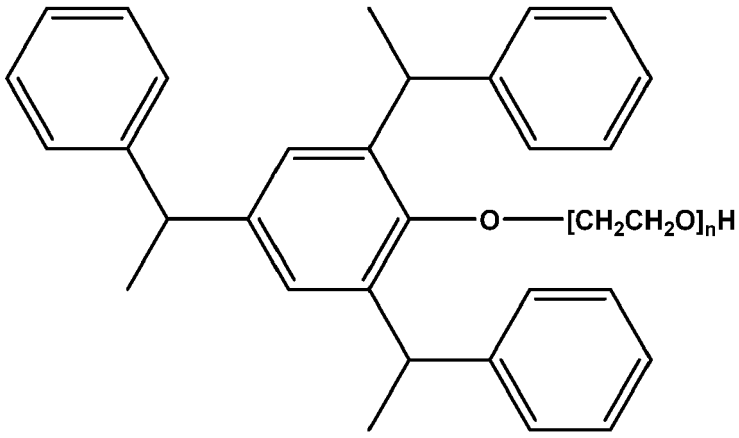
**[0056]** Alkoxylated polyaryl/polyalkyl phenol: A suitable alkoxylated polyaryl/polyalkyl phenol has the following structure:




wherein $R_1$ is selected from linear of branched $C_3$-$C_{15}$ alkyl groups and aryl groups, X is selected from ethoxy or propoxy groups, n is from 2 to 70, T is selected from H, $SO_3^-$, $COO^-$ and $PO_3^{2-}$

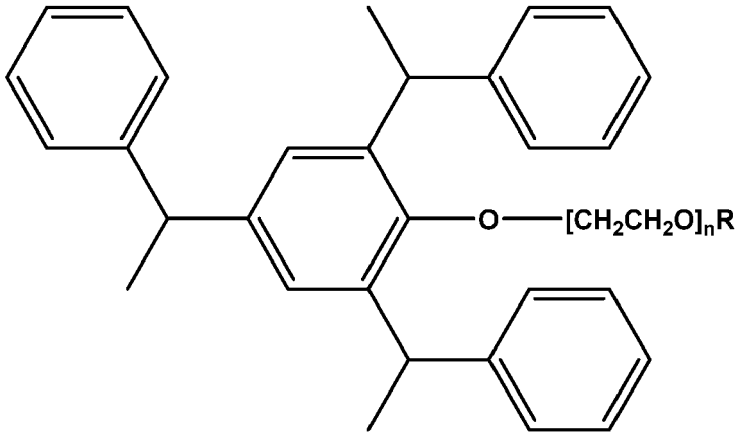
**[0057]** The alkoxylated polyaryl or alkoxylated polyalkyl phenol is preferably selected from groups (i) to (iv):

(i) Uncharged alkoxylated tristyrylphenols of the following structure:



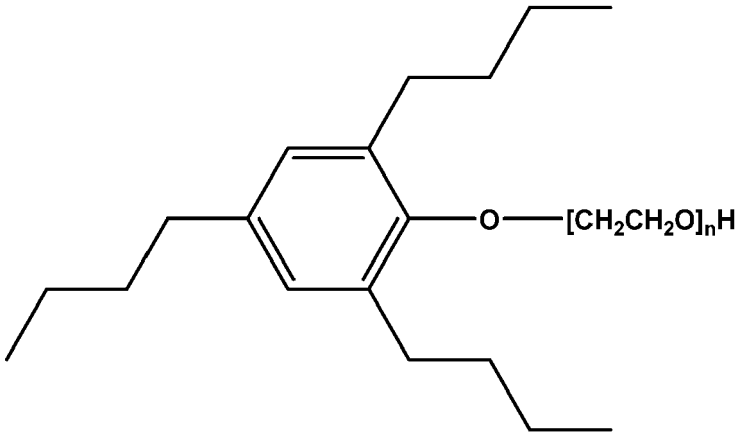
wherein n is selected from 2 to 70, more preferably n is selected from 10 to 54, most preferably n = 16 or 20.

(ii) Anionic alkoxylated tristyrylphenols of the following structure



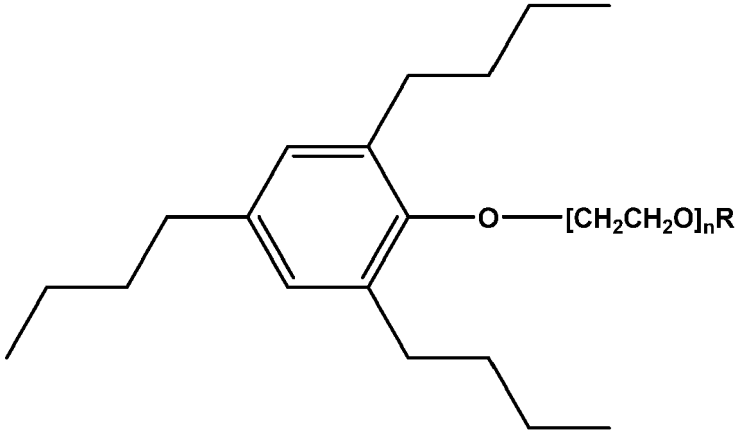

wherein R is selected from $SO_3^-$, $COO^-$ and $PO_3^{2-}$, preferably selected from $SO_3^-$ and $COO^-$, wherein n is selected from 2 to 54.

(iii) Uncharged alkoxylated tri(n-butyl)phenols of the following structure:




wherein n is selected from 2 to 50

(iv) Anionic alkoxylated tri(n-butyl)phenols of the following structure:



wherein R is selected from $SO_3^-$, $COO^-$ and $PO_3^{2-}$, preferably selected from $SO_3^-$ and $COO^-$, wherein n is selected from 6 to 50.

**[0058]** Such compounds are available from industrial suppliers, for example Solvay under the Soprophor trade name, from Clariant under the Emulsogen trade name, Aoki Oil Industrial Co. under the Blaunon trade name, from Stepan under the Makon trade name, and from TOTO Chemical Industry Co. under the Sorpol trade name. Specific examples of suitable compounds are Emulsogen® TS160, Hostapal® BV conc., Sapogenat® T110 or Sapogenat® T139, all from Clariant.

**[0059]** The alkoxylated polyaryl/polyalkyl phenol may be present at levels of 0.5-20wt%, preferably 1-15wt%, most preferably 3-10wt%.

**[0060]** Amylase variant: A suitable amylase variant comprises:

(a) a deletion and/or a substitution at two or more positions corresponding to positions R181, G182, H183 and G184 of the mature polypeptide of SEQ ID NO: 1 , and

(b) a substitution at one or more positions said substitutions selected from the group consisting of:

I206Y;F;Q;P;R;V;C;G;A;C;D;E;H;K;L;M;N;S;T, particularly I206Y;F;C;L;H;S,
N195F;Y;H;K;L,
L63Q;P;R;V;F;C;G;A;C;D;E;H;K;I;M;N;S;T;Y, particularly L63V,
A113M;R;W;I;L,
M116F;Y;I;W;L,
R118P;Q;V;F;C;G;A;C;D;E;H;I;K;L;M;N;S;T;Y, particularly R118P;Q;V;F;C;G, N128C;
Q129P;R;V;F;C;G;A;C;D;E;H;I;K;L;M;N;S;T;Y, particularly Q129E, G133N,
A139Q;P;R;V;F;C;G;C;D;E;H;I;K;L;M;N;S;T;Y, particularly A139T,
R142H;V;L;Q;I,
A186E;N;Q;S,
E190P;R;V;F;C;G;A;C;D;Q;H;I;K;L;M;N;S;T;Y, particularly E190P,
A204Q;P;R;V;F;C;G;C;D;E;H;I;K;L;M;N;S;T;Y, particularly A204T,
H210M;D;C;A;Q;S;F;N;E;T,
P211Q;R;V;F;C;G;A;C;D;E;H;1;K;L;M;N;S;T;Y,particularly P211L;M;S;Q;G;V;W;A;H;T;R;
E212T;R;S;V;L;Y;R;T;G;
V213Q;P;R;F;C;G;A;C;D;E;H;I;K;L;M;N;S;T;Y, particularly V213T;A;G;S;C;L;P,
V214Q;P;R;F;C;G;A;C;D;E;H;I;K;L;M;N;S;T;Y, particularly V214T;I,
L217M;Q;V;I;H, particularly L217V,
Y243Q;P;R;F;C;G;A;C;D;E;H;I;K;L;M;N;S;T;V, particularly Y243F,
S244Q;P;R;F;C;G;A;C;D;E;H;I;K;L;M;N;Y;T;V, particularly S244Q,
T246Q;P;R;F;C;G;A;C;D;E;H;I;K;L;M;N;Y;S;V, particularly T246Q;M,
N260E, Q280S, N311R, F343W, D418C, S419M, S420Q;R and Y482W,

where the positions correspond to the positions of SEQ ID NO 1 and wherein the amylase variant has at least 95%, such as at least 96%, or at least 97%, or at least 98%, or at least 99% but less than 100% sequence identity to the polypeptide having the amino acid sequence of SEQ ID NO: 1 and wherein the variant has alpha-amylase activity.

**[0061]** One preferred amylase variant comprises a sequence corresponding to SEQ ID NO: 1 with the following mutations: H183*+G184*+I405L+A421H+A422P+A428T.

**[0062]** A suitable amylase is commercially available from Novozymes under the Amplify® brand name, for example as a liquid raw material as Amplify® 12L.

**[0063]** Lipase: A suitable lipase is a variant of SEQ ID NO:2 comprising:

(a) substitutions T231R andN233R
and

(b) at least three further substitutions selected from D27R, N33Q, G38A, D96E, D111A, G91Q, G163K, E210Q, D254S, I255A, and P256T;

where the positions correspond to the positions of SEQ ID NO 2 and wherein the lipase variant has at least 95% but less than 100% sequence identity to the polypeptide having the amino acid sequence of SEQ ID NO: 2 and wherein the

variant has lipase activity.

**[0064]** One preferred lipase is a variant of SEQ ID NO: 2 comprising the following substitutions: T231R, N233R, D27R, G38A, D96E, D111A, G163K, D254S and P256T

**[0065]** One preferred lipase is a variant of SEQ ID NO: 2 comprising the following substitutions: T231R, N233R, N33Q, G91Q, E210Q, I255A.

**[0066]** Suitable lipases are commercially available from Novozymes, for example as Lipex Evity 100L (a liquid raw material) and Lipex Evity 105T (a granulate). These lipases have different structures to the products Lipex 100L, Lipex 100T and Lipex Evity 100T which are outside the scope of this particular lipase definition.

**[0067]** Metalloprotease: Metalloproteases can be derived from animals, plants, bacteria or fungi. Suitable metalloprotease can be selected from the group of neutral metalloproteases and *Myxobacter* metalloproteases. Suitable metalloproteases can include collagenases, hemorrhagic toxins from snake venoms and thermolysin from bacteria.

**[0068]** Preferred thermolysin enzyme variants include an M4 peptidase, more preferably the thermolysin enzyme variant is a member of the PepSY~Peptidase_M4~Peptidase_M4_C family.

**[0069]** Suitable metalloprotease variants can have at least 50% identity to the thermolysin set forth in SEQ ID NO: 3. In some embodiments, the thermolysin enzyme variant is from a genus selected from the group consisting of *Bacillus, Geobacillus, Alicyclobacillus, Lactobacillus, Exiguobacterium, Brevibacillus, Paenibacillus, Herpetosiphon, Oceanobacillus, Shewanella, Clostridium, Staphylococcus, Flavobacterium, Stigmatella, Myxococcus, Vibrio, Methanosarcina, Chryseobacterium, Streptomyces, Kribbella, Janibacter, Nocardioides, Xanthamonas, Micromonospora, Burkholderia, Dehalococcoides, Croceibacter, Kordia, Microscilla, Thermoactinomyces, Chloroflexus, Listeria, PLesiocystis, Haliscomenobacter, Cytophaga, Hahella, Arthrobacter, Brachybacterium, Clavibacter, Microbacterium, Intrasporangium, Frankia, Meiothermus, Pseudomonas, Ricinus, Catenulispora, Anabaena, Nostoc, Halomonas, Chromohalobacter, Bordetella, Variovorax, Dickeya, Pectobacterium, Citrobacter, Enterobacter, Salmonella, Erwinia, Pantoea, Rahnella, Serratia, Geodermatophilus, Gemmata, Xenorhabdus, Photorhabdus, Aspergillus, Neosartorya, Pyrenophora, Saccharopolyspora, Nectria, Gibberella, Metarhizium, Waddlia, Cyanothece, Cellulphaga, Providencia, Bradyrhizobium, Agrobacterium, Mucilaginibacter, Serratia, Sorangium, Streptosporangium, Renibacterium, Aeromonas, Reinekea, Chromobacterium, Moritella, Haliangium, Kangiella, Marinomonas, Vibrionales, Listonella, Salinivibrio, Photobacterium, Alteromonadales, Legionella, Teredinibacter, Reinekea, Hydrogenivirga and Pseudoalteromonas.* In some embodiments, the thermolysin enzyme variant is from a genus selected from the group consisting of *Bacillus, Geobacillus, Alicyclobacillus, Lactobacillus, Exiguobacterium, Brevibacillus, Paenibacillus, Herpetosiphon, Oceanobacillus, Shewanella, Clostridium, Staphylococcus, Flavobacterium, Stigmatella, Myxococcus, Vibrio, Methanosarcina, Chryseobacterium, and Pseudoalteromonas.*

**[0070]** Preferably the thermolysin enzyme is from the genus *Bacillus.*

**[0071]** Preferred metalloproteases include thermolysin, matrix metalloproteinases and those metalloproteases derived from *Bacillus subtilis, Bacillus thermoproteolyticus, Geobacillus stearothermophilus* or *Geobacillus sp.*, or Bacillus amyloliquefaciens, as described in US PA 2008/0293610A1.

**[0072]** A specially preferred metalloprotease belongs to the family EC3.4.24.27.

**[0073]** Further suitable metalloproteases are the thermolysin variants described in WO2014/71410.

**[0074]** In one aspect the metalloprotease is a variant of a parent protease, said parent protease having at least 60%, or 80%, or 85% or 90% or 95% or 96% or 97% or 98% or 99% or even 100% identity to SEQ ID NO:3 including those with substitutions at one or more of the following sets of positions versus SEQ ID NO:3:

(a) 2, 26, 47, 53, 87, 91,96, 108, 118, 154, 179, 197, 198, 199, 209, 211, 217, 219, 225, 232, 256, 257, 259, 261, 265, 267, 272,276, 277, 286, 289, 290, 293, 295, 298, 299, 300,301,303,305,308,311 and 316;
(b) 1, 4, 17, 25, 40, 45, 56, 58, 61, 74, 86, 97, 101, 109, 149, 150 , 158, 159, 172, 181, 214, 216, 218, 221, 222, 224, 250, 253, 254, 258, 263, 264, 266, 268, 271, 273, 275, 278, 279, 280, 282, 283, 287, 288, 291, 297, 302, 304, 307 and 312;
(c) 5, 9, 1l, 19, 27, 31, 33, 37, 46, 64, 73, 76, 79, 80, 85, 89, 95, 98, 99, 107, 127, 129, 131, 137, 141, 145, 148, 151, 152, 155, 156, 160, 161, 164, 168, 171, 176, 180, 182, 187, 188, 205, 206, 207, 210, 212, 213, 220, 227, 234 , 235, 236, 237, 242, 244, 246, 248, 249, 252, 255, 270, 274, 284, 294, 296, 306, 309, 310, 313, 314 and 315;
(d) 3, 6, 7, 20, 23, 24, 44, 48, 50, 57, 63, 72, 75, 81, 92, 93, 94, 100, 102, 103, 104, 110, 117, 120, 134, 135, 136, 140, 144, 153, 173, 174, 175, 178, 183, 185, 189, 193, 201, 223, 230, 238, 239, 241, 247, 251, 260, 262, 269, and 285;
(e) 17, 19, 24, 25, 31, 33, 40, 48, 73, 79, 80, 81, 85, 86, 89, 94, 109, 117, 140, 141, 150, 152, 153, 158, 159, 160, 161, 168, 171, 174, 175, 176, 178, 180, 181, 182, 183, 189, 205, 206, 207, 210, 212, 213, 214, 218, 223, 224,227, 235, 236, 237, 238, 239, 241, 244, 246, 248, 249, 250, 251, 252, 253, 254, 255, 258, 259, 260, 261, 262, 266, 268, 269, 270, 271, 272, 273, 274, 276, 278, 279, 280, 282, 283, 294, 295, 296, 297, 300, 302, 306, 310 and 312;
(f) 1, 2, 127, 128, 180, 181, 195, 196, 197, 198, 199, 211, 223, 224, 298, 299, 300, and 316

all relative to SEQ ID NO:3.

**[0075]** In a further aspect the metalloprotease protease is a variant of a parent protease, said parent protease having at least 60%, or 80%, or 85% or 90% or 95% or 96% or 97% or 98% or 99% or even 100% identity to SEQ ID NO:3 including those with substitutions at one or more of the following sets of positions versus SEQ ID NO:3:

(a) I001L, T002A, T002C, T002I, T002K, T002M, T004K, T004L, T004M, T004Y, Q017L, N037K, F040K, F040L, K045A, K045G, K045M, T049E, T049M, T049Y, L050P, S053C, S053L, A056M, A058E, A058L, Q061L, F063C, A064D, A064E, S065A, S065D, S065E, S065P, S065Y, V087C, V087K, V087L, V087M, V087N, V087Q, V087W, V087Y, N096K, N096L, N096Y, R101H, Q108L, Q108M, G109E, G109M, G109R, G109W, S118A, S118D, S118M, S118Q, S118R, S118T, SI 18V, Q128A, Q128L, Q128Y, I131L, I137L, T149N, G154A, G154H, G154K, G154M, G154Y, L155M, I164A, N181S, G196A, G196W, I197C, S198A, S198K, G199A, G199Y, A209C, A209M, H216A, Y217C, Y217L, T222K, N227A, I244L, Q246D, V256N, L263A, L263M, T272K, Q273N, Y274M, P277A, P277D, P277Y, L284A, L284M, L284Y, A286K, A286L, A286M, A286N, A286Y, A287C, A288L, A288M, V289A, S291A, S291T, T293A, T293I, T293K, T293L, T293M, T293Y, L295A, L295K, L295M, L295W, Y296M, G297N, S298A, S298G, S298K, S298M, S298R, T299A, T299K, S300D, S300N, Q301K, E302A, V303A, V303P, V303Y, A304E, A304K, A304Y, S305A, S305K, S305M, V306L, V306T, A309C, F310M, D311A, D311K, D311L, D311M, D311V, D311W,D311Y, and A312C;

(b) T002Q, T004V, V007I, V009I, R01 IK, I020L, I020V, S025A, S025C, S025K, S025M, S025R, T026C, T026D, Y027C, Y027L, N037L, F040A, A044C, K045F, K045H, K045Q, K045Y, Y046C, R047D, R047E, R047G, R047L, R047M, R047Q, R047T, T049L, T049N, T049Q, T049V, S053A, S053N, S053V, A056E, Q061C, Q061I, A064T, S065L, S065T, S065W, A073F, A073L, A073M, A073W, H074C, H074F, H074M, H074N, H074Q, H074W, T080L, T080N, K085S, N086D, V087R, V087T, L091A, L091N, L091R, L091W, L091Y, S092L, Y093C, N096G, N096H, N096Q, N096R, N096S, N096W, N097E, N097M, A099R, A099S, R101C, R101L, R101S, S102N, S107G, Q108I, Q108K, Q108N, G109S, S118E, M120L, Q128I, Q128K, T129L, T129M, I131W, S134P, G136S, I137E, I137T, I137V, V140D, V148A, V148Q, T149D, T149S, T152G, G154C, G154N, L155I, N159S, N159Y, I164C, I168L, I171G, Y179F, A180S, G189A, Y193F, G196H, G196L, G196Y, I197F, S198M, S198N, S198R, S198W, S201A, A209G, A209I, A209K, A209P, A209R, A209Y, Y211E, Y211R, P214A, P214R, Y217A, Y217F, Y217M, Y217N, K219A, K219E, K219R, K219S, R220A, Y221A, Y221F, Y221G, Y221M, T222A, T222M, Q225C, Q225E, Q225K, Q225L, Q225S, I232L, I232R, I232S, I232T, I232V, I232Y, S234A, S234C, G235A, I236C, I244A, I244M, Q246C, V256S, G257K, G257R, I258A, I258C, I258K, I258Q, I258V, G259N, G259S, G259T, L263H, L263K, L263N, L263V, G264A, G264N, G264P, G264Q, G264S, G264T, K265N, I266C, I266M, I266T, I266V, F267A, F267C, F267H, F267I, F267K, F267L, F267M, F267T, F267Y, R269K, A270G, L271H, T272A, Q273E, Q273G, L275C, L275Q, L275S, L275T, T276A, T276L, T276V, T276Y, P277E, P277F, P277G, P277H, P277N, P277R, P277V, P277W, S279G, R285Y, A286C, A286Q, A286R, A286T, A288N, V289L, V289M, V289Y, Q290A, Q290H, Q290N, S291V, T293N, T293V, T293W, D294N, L295F, L295G, Y296W, G297D, S298E, S298N, S298P, T299N, S300A, S300G, S300T, Q301M, Q301S, Q301T, Q301V, E302D, E302Q, V303G, V303K, V303L, V303R, V303W, A304R, A304S, A304T, A304W, S305H, S305T, S305V, V306I, Q308A, Q308L, F310C, F310W, D311F, D311G, D311I, D311Q, D311S, D311T, V313C, G314Q, V315L, V315T, K316A, and K316M;

(c) I001K, I001M, I001V, T002F, T002L, T002P, T002S, T002V, T002W, T002Y, T004E,S005D, S005N, S005P, T006C, RO11I, Q017I, Q017W, Q017Y, S025D, S025F, T026K, T026L, T026R,T026V, T026Y, Y027W, Q031A, Q031K, Q031V, N033S, N033T, N037D, N037Q, N037R, F040E, F040G, F040M, F040Q, F040S, F040Y, K045E, K045L, K045S, Y046L, R047A, R047C, R047H, R047K, R047N, T048E, T049A, T049D, T049F, T049H, T049I, T049S, S053F, S053H, S053I, S053M, S053Q, S053T, S053W, A056K, A056Q, A056V, A056W, Q061M, S065I, S065M, S065Q, S065V, D072F, H074E, H074L, Y076H, Y076L, Y076M, Y076Q, V079L, V079Q, V079T, T080I, Y081F, K085E, N086L, N086S, V087D, V087E, V087G, V087I, V087S, L091D, L091E, L091F, L091K, L091M, L091P, L091Q, L091S, Y093T, G095A, G095D, G095H, G095M, G095N, G095S, N096C, N096D, N096I, N096V, N097K, A098C, A098E, A098H, A098R, A099E, A099K, A099P, S107D, Q108C, Q108E, Q108F, Q108H, G127C, G127D, G127E, Q128C, Q128D, Q128E, Q128R, Q128S, T129I, T129R, S134A, I137P, A141S, T145A, T145C, T145E, T145G, T145M, T145N, T145Q, V148L, V148N, V148Y, T149M, T149V, Y151K, T152S, A153T, G154L, G154Q, G154S, G154T, L155C, Q158A, Q158K, Q158M, Q158N, N159R, N159W, S161A, S161N, S161P, S161T, I164L, I164N, I164S, I164T, I164V, I171C, I171E, I171F, I171L, I171S, F172G, F172L, F172M, F172Q, F172S, F172V, F172W, F172Y, G173A, G173C, T174C, V176L, V176N, N181L, G196D, G196E, G196T, I197D, I197K, I197L, I197T, I197V, I197W, I197Y, S198C, S198E, S198F, S198G, S198H, S198I, S198P, S198Q, S198T, S198V, G199C, G199E, G199F, G199H, G199Q, G199S, G199T, G199W, M205L, A209D, A209E, A209L, A209S, A209T, A209V, Y211A, Y211C, Y211D, Y211F, Y211G, Y211H, Y211I, Y211L, Y211N, Y211Q, Y211S, Y211T, D213N, D213S, P214C, P214G, P214K, P214S, H216C, H216E, H216S, H216T, Y217Q, Y217S, Y217T, Y217V, Y217W, S218K, S218L, S218Y, K219D, K219F, K219G, K219H, K219I, K219M, K219N, K219Q, K219T, R220K, R220V, Y221K, Y221N, Y221Q, Y221R, Y221S, Y221T, Y221V, T222C, T222D, T222L, T222Y, T224K, T224M, Q225D, Q225G, Q225H, Q225I, Q225P, Q225V, Q225W, I232C, I232E, I232F, I232K, I232M, I232N, I232Q, I232W, S234D,

G235M, I236M, Y242C, Y242F, Y242N, Y242V, I244T, I244V, Q246E, Q246N, Q246T, G247A, G247S, T249K, T249M, T249N, H250A, H250C, G252K, G252Y, V253N, V253T, S254A, S254M, S254R, S254Y, V255L, V255P, V256L, V256T, G257C, G257D, G257E, G257L, G257N, G257P, G257Q, G257S, G257T, G257Y, I258E, I258L, I258M, I258N, G259A, G259C, G259E, G259F, G259H, G259L, G259M, G259W, D261A, D261N, L263C, L263I, L263Q, L263T, K265A, K265C, K265D, K265M, K265P, K265Q, K265S, I266A, I266F, I266L, I266S, F267E, F267G, F267N, F267S, F267V, F267W, Y268M, Y268Q, Y268V, A270C, A270F, A270I, A270L, A270S, L271A, L271D, L271F, L271I, T272E, T272L, T272V, T272W, Q273A, Q273H, Q273Y, Y274F, Y274H, L275I, L275M, L275V, T276C, T276F, T276I, T276P, T276Q, T276W, P277Q, P277S, P277T, T278G, S279A, S279D, S279I, S279L, S279M, S279N, S279Q, S279T, N280A, N280C, N280D, N280E, S282K, S282N, L284V, L284W, R285K, A286D, A286E, A286F, A286G, A286H, A286I, A286S, A287I, A287L, A287N, A287V, A287Y, A288C, A288I, A288S, A288T, A288V, V289C, V289E, V289F, V289G, V289I, V289N, V289S, V289W, Q290C, Q290D, Q290F, Q290G, Q290L, Q290W, S291E, T293C, T293E, T293F, T293G, T293H, T293Q, T293S, L295C, L295I, L295N, Y296N, G297A, G297M, G297R, G297Y, S298C, S298T, S298W, S298Y, T299C, T299F, T299L, T299M, T299R, T299W, S300C, S300K, S300M, S300R, S300Y, Q301E, Q301H, Q301P, Q301R, V303C, V303H, A304C, A304D, A304L, A304N, S305G, S305I, S305L, S305N, S305W, S305Y, V306A, V306S, K307A, K307C, K307G, K307I, K307M, K307N, K307Q, K307R, K307W, K307Y, Q308C, Q308D, Q308F, Q308G, Q308I, Q308M, A309G, A309S, D311C, D311E, A312G, A312M, A312V, V313T, G314A, G314E, G314H, G314M, G314S, G314W, V315A, V315C, V315I, V315M, K316D, K316E, K316F, K316G, K316H, K316L, K316N, K316P, K316Q, K316R, K316S, K316V, K316W and K316Y.

**[0076]** Further suitable metalloproteases are the NprE variants described in WO2007/044993, WO2009/058661 and US 2014/0315775.

**[0077]** In one aspect the protease is a variant of a parent protease, said parent protease having at least 45%, or 60%, or 80%, or 85% or 90% or 95% or 96% or 97% or 98% or 99% or even 100% identity to SEQ ID NO:4 including those with substitutions at one or more of the following sets of positions versus SEQ ID NO:4:

S23, Q45, T59, S66, S129, F130, M138, V190, S199, D220, K211, and G222,

**[0078]** Another suitable metalloprotease is a variant of a parent protease, said parent protease having at least 60%, or 80%, or 85% or 90% or 95% or 96% or 97% or 98% or 99% or even 100% identity to SEQ ID NO:4 including those with substitutions at one or more of the following sets of positions versus SEQ ID NO:4:

Q45E, T59P, 566E, S129I, S129V, F130L, M138I, V190I, S199E, D220P, D220E, K211V, K214Q, G222C, M138L/D220P, F130L/D220P, S129I/D220P, V190I/D220P, M138L/V190I/D220P, S129I/V190I, S129V/V190I, S129V/D220P, S129I/F130L/D220P, T004V/S023N, T059K/S66Q/S129I, T059R/S66N/S129I, S129I/F130L/M138L/V190I/D220P and T059K/S66Q/S129V.

**[0079]** Especially preferred metalloproteases for use herein belong belong to EC classes EC 3.4.22 or EC3.4.24, more preferably they belong to EC classes EC3.4.22.2, EC3.4.24.28 or EC3.4.24.27. The most preferred metalloprotease for use herein belong to EC3.4.24.27.

**[0080]** Suitable commercially available metalloprotease enzymes include those sold under the trade names Neutrase® by Novozymes A/S (Denmark), the Corolase® range including Corolase® 2TS, Corolase® N, Corolase® L10, Corolase® LAP and Corolase® 7089 from AB Enzymes, Protex 14L and Protex 15L from DuPont (Palo Alto, California), those sold as thermolysin from Sigma and the Thermoase range (PC10F and C100) and thermolysin enzyme from Amano enzymes.

**[0081]** A preferred metalloprotease is selected from the M4 Metalloprotease Family.

**[0082]** Builder system: A suitable water-soluble builder system comprising one or more aminocarboxylates, selected from: methylglycine diacetic acid (MGDA) and/or alkali metal or ammonium salts thereof; N,N-dicarboxymethyl glutamic acid (GLDA) and/or alkali metal or ammonium salts thereof; Aspartic acid N,N-diacetic acid (ASDA) and/or alkali metal or ammonium salts thereof; Ethylene diamine-N,N'-disuccunic acid (EDDS) and/or alkali metal or ammonium salt thereof; 2-hydroxy propylene diamine-N,N'-disuccunic acid (HPDDS), and/or alkali metal or ammonium salt thereof; ethylenediamine-N,N'-diglutaric acid (EDDG and/or alkali metal or ammonium salt thereof; ethylenediamine-N,N'-bis-(orthohydroxyphenyl)acetic acid (EDDHA) and/or alkali metal or ammonium salt thereof; N-hydroxyethyl ethylenediamine-N,N',N'-triacetic acid (HEDTA) alkali metal or ammonium salts thereof; iminodisuccinate, hydroxyethyl iminodiacetate, and ethylene iminodisuccinate and the respective alkali metal or ammonium salts; and any combination thereof.

**[0083]** Phosphonate chelant: A suitable phosphonate chelant is selected from: 1-hydroxyethane-1,1-diphosphonic acid (HEDP); Diethylene triamine pentamethylene phosphonic acid (DTPMP, CW-Base); 2-phosphonobutane-1,2,4-tricarboxylic acid (PBTC); Amino trimethylene phosphonic acid (ATMP); Ethylenediamine tetramethylene phosphonic acid (EDTMP); Diethylenetriamine pentamethylene phosphonic acid (DTPMP); Aminotrimethylene phosphonic acid

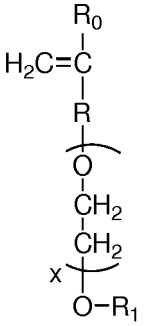
(ATMP); salts of the aforementioned materials; and any combination thereof.

**[0084]** Carboxylate polymer: The composition may comprise a carboxylate polymer, such as a maleate/acrylate random copolymer, maleic-olefin copolymers or polyacrylate homopolymer. Suitable carboxylate polymers include: polyacrylate homopolymers having a molecular weight of from 4,000 Da to 9,000 Da; maleate/acrylate random copolymers having a molecular weight of from 50,000 Da to 100,000 Da, or from 60,000 Da to 80,000 Da. Examples of the foregoing include Acusol 410N, Acusol 445N (polyacrylic acid, Na salt); Acusol 450N and Acusol 480N (modified polyacrylic acid, Na salt); Acusol 479N, Acusol 490N, and Acusol 505N (acrylic acid/maleic acid, Na salt); Acusol 460N (maleic acid/olefin, Na salt); Sokolan CP5 and Sokolan CP12S (maleic acid/acrylic acid, Na salt); and Sokolan CP 9 (maleic acid/olefin, Na salt). The Acusol series are available from Rohm & Haas, Philadelphia, PA and the Sokolan series are available from BASF (Germany and New Jersey).

**[0085]** Suitable carboxylate polymers can contain other monomers including modified acrylic, fumaric, maleic, itaconic, aconitic, mesaconic, citraconic and methylenemalonic acid or their salts, modified maleic anhydride, acrylamide, alkylene, vinylmethyl ether, styrene and any mixtures thereof. Suitable carboxylate polymers can also containing 2-acrylamido-2-methyl-1-propanesulfonic acid, 2-methacrylamido-2-methyl-1-propanesulfonic acid, 3-methacrylamido-2-hydroxy-propanesulfonic acid, allysulfonic acid, methallysulfonic acid, 2-hydroxy-3-(2-propenyloxy)propanesulfonic acid, 2-methyl-2-propenen-1-sulfonic acid, styrenesulfonic acid, vinylsulfonic acid, 3-sulfopropyl acrylate, 3-sulfopropylmethacrylate, sulfomethylacrylamide, sulfomethylmethacrylamide and water soluble salts thereof.

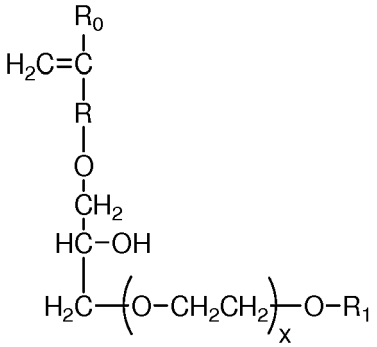
**[0086]** Another suitable carboxylate polymer is a co-polymer that comprises: (i) from 50 to less than 98 wt% structural units derived from one or more monomers comprising carboxyl groups; (ii) from 1 to less than 49 wt% structural units derived from one or more monomers comprising sulfonate moieties; and (iii) from 1 to 49 wt% structural units derived from one or more types of monomers selected from ether bond-containing monomers represented by formulas (I) and (II):

formula (I):



wherein in formula (I), $R_0$ represents a hydrogen atom or $CH_3$ group, R represents a $CH_2$ group, $CH_2CH_2$ group or single bond, X represents a number 0-5 provided X represents a number 1-5 when R is a single bond, and $R_1$ is a hydrogen atom or $C_1$ to $C_{20}$ organic group;

formula (II)



wherein in formula (II), $R_0$ represents a hydrogen atom or $CH_3$ group, R represents a $CH_2$ group, $CH_2CH_2$ group or single bond, X represents a number 0-5, and $R_1$ is a hydrogen atom or $C_1$ to $C_{20}$ organic group.

It may be preferred that the polymer has a weight average molecular weight of at least 50kDa, or even at least 70kDa.

**[0087]** Soil release polymer: The composition may comprise a soil release polymer. A suitable soil release polymer has a structure as defined by one of the following structures (I), (II) or (III):

(I) $-[(OCHR^1\text{-}CHR^2)_a\text{-}O\text{-}OC\text{-}Ar\text{-}CO\text{-}]_d$

(II) $-[(OCHR^3\text{-}CHR^4)_b\text{-}O\text{-}OC\text{-}sAr\text{-}CO\text{-}]_e$

(III) $-[(OCHR^5\text{-}CHR^6)_c\text{-}OR^7]_f$

wherein:

a, b and c are from 1 to 200;
d, e and f are from 1 to 50;
Ar is a 1,4-substituted phenylene;
sAr is 1,3-substituted phenylene substituted in position 5 with $SO_3Me$;
Me is Li, K, Mg/2, Ca/2, Al/3, ammonium, mono-, di-, tri-, or tetraalkylammonium wherein the alkyl groups are $C_1$-$C_{18}$ alkyl or $C_2$-$C_{10}$ hydroxyalkyl, or mixtures thereof;
$R^1$, $R^2$, $R^3$, $R^4$, $R^5$ and $R^6$ are independently selected from H or $C_1$-$C_{18}$ n- or iso-alkyl; and
$R^7$ is a linear or branched $C_1$-$C_{18}$ alkyl, or a linear or branched $C_2$-$C_{30}$ alkenyl, or a cycloalkyl group with 5 to 9 carbon atoms, or a $C_8$-$C_{30}$ aryl group, or a $C_6$-$C_{30}$ arylalkyl group.

Suitable soil release polymers are sold by Clariant under the TexCare® series of polymers, e.g. TexCare® SRN240 and TexCare® SRA300. Other suitable soil release polymers are sold by Solvay under the Repel-o-Tex® series of polymers, e.g. Repel-o-Tex® SF2 and Repel-o-Tex® Crystal.

**[0088]** Anti-redeposition polymer: Suitable anti-redeposition polymers include polyethylene glycol polymers and/or polyethyleneimine polymers.

**[0089]** Suitable polyethylene glycol polymers include random graft co-polymers comprising: (i) hydrophilic backbone comprising polyethylene glycol; and (ii) hydrophobic side chain(s) selected from the group consisting of: $C_4$-$C_{25}$ alkyl group, polypropylene, polybutylene, vinyl ester of a saturated $C_1$-$C_6$ mono-carboxylic acid, $C_1$-$C_6$ alkyl ester of acrylic or methacrylic acid, and mixtures thereof. Suitable polyethylene glycol polymers have a polyethylene glycol backbone with random grafted polyvinyl acetate side chains. The average molecular weight of the polyethylene glycol backbone can be in the range of from 2,000 Da to 20,000 Da, or from 4,000 Da to 8,000 Da. The molecular weight ratio of the polyethylene glycol backbone to the polyvinyl acetate side chains can be in the range of from 1:1 to 1:5, or from 1:1.2 to 1:2. The average number of graft sites per ethylene oxide units can be less than 1, or less than 0.8, the average number of graft sites per ethylene oxide units can be in the range of from 0.5 to 0.9, or the average number of graft sites per ethylene oxide units can be in the range of from 0.1 to 0.5, or from 0.2 to 0.4. A suitable polyethylene glycol polymer is Sokalan HP22. Suitable polyethylene glycol polymers are described in WO08/007320.

**[0090]** Cellulosic polymer: Suitable cellulosic polymers are selected from alkyl cellulose, alkyl alkoxyalkyl cellulose, carboxyalkyl cellulose, alkyl carboxyalkyl cellulose, sulphoalkyl cellulose, more preferably selected from carboxymethyl cellulose, methyl cellulose, methyl hydroxyethyl cellulose, methyl carboxymethyl cellulose, and mixures thereof.

**[0091]** Suitable carboxymethyl celluloses have a degree of carboxymethyl substitution from 0.5 to 0.9 and a molecular weight from 100,000 Da to 300,000 Da.

Suitable carboxymethyl celluloses have a degree of substitution greater than 0.65 and a degree of blockiness greater than 0.45, e.g. as described in WO09/154933.

**[0092]** Care polymers: Suitable care polymers include cellulosic polymers that are cationically modified and/or hydrophobically modified. Such modified cellulosic polymers can provide anti-abrasion benefits and dye lock benefits to fabric during the laundering cycle. Suitable cellulosic polymers include cationically modified hydroxyethyl cellulose. Suitable care polymers also include guar polymers that are cationically and/or hydrophobically modified. Other suitable care polymers include dye lock polymers, for example the condensation oligomer produced by the condensation of imidazole and epichlorhydrin, preferably in ratio of 1:4:1. A suitable commercially available dye lock polymer is Polyquart® FDI (Cognis).

**[0093]** Other suitable care polymers include amino-silicone, which can provide fabric feel benefits and fabric shape retention benefits.

**[0094]** Alkoxylated polyalkyleneimine: The composition may comprise an alkoxylated polyalkyleneimine, wherein said alkoxylated polyalkyleneimine has a polyalkyleneimine core with one or more side chains bonded to at least one nitrogen atom in the polyalkyleneimine core, wherein said alkoxylated polyalkyleneimine has an empirical formula (I) of $(PEI)_a\text{-}(EO)_b\text{-}R_1$, wherein a is the average number-average molecular weight ($MW_{PEI}$) of the polyalkyleneimine core of

the alkoxylated polyalkyleneimine and is in the range of from 100 to 100,000 Daltons, wherein b is the average degree of ethoxylation in said one or more side chains of the alkoxylated polyalkyleneimine and is in the range of from 5 to 40, and wherein $R_1$ is independently selected from the group consisting of hydrogen, $C_1$-$C_4$ alkyls, and combinations thereof.

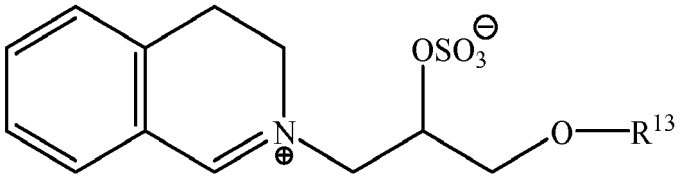
**[0095]** The composition may comprise an alkoxylated polyalkyleneimine, wherein said alkoxylated polyalkyleneimine has a polyalkyleneimine core with one or more side chains bonded to at least one nitrogen atom in the polyalkyleneimine core, wherein the alkoxylated polyalkyleneimine has an empirical formula (II) of $(PEI)_o$-$(EO)_m(PO)_n$-$R_2$ or $(PEI)_o$-$(PO)_n(EO)_m$-$R_2$, wherein o is the average number-average molecular weight ($MW_{PEI}$) of the polyalkyleneimine core of the alkoxylated polyalkyleneimine and is in the range of from 100 to 100,000 Daltons, wherein m is the average degree of ethoxylation in said one or more side chains of the alkoxylated polyalkyleneimine which ranges from 10 to 50, wherein *n* is the average degree of propoxylation in said one or more side chains of the alkoxylated polyalkyleneimine which ranges from 1 to 50, and wherein $R_2$ is independently selected from the group consisting of hydrogen, $C_1$-$C_4$ alkyls, and combinations thereof.

**[0096]** Bleach: Suitable bleach includes sources of hydrogen peroxide, bleach activators, bleach catalysts, pre-formed peracids and any combination thereof. A particularly suitable bleach includes a combination of a source of hydrogen peroxide with a bleach activator and/or a bleach catalyst.

**[0097]** Source of hydrogen peroxide: Suitable sources of hydrogen peroxide include sodium perborate and/or sodium percarbonate.

**[0098]** Bleach activator: Suitable bleach activators include tetra acetyl ethylene diamine and/or alkyl oxybenzene sulphonate.

**[0099]** Bleach catalyst: The composition may comprise a bleach catalyst. Suitable bleach catalysts include oxaziridinium bleach catalysts, transistion metal bleach catalysts, especially manganese and iron bleach catalysts. A suitable bleach catalyst has a structure corresponding to general formula below:




wherein $R^{13}$ is selected from the group consisting of 2-ethylhexyl, 2-propylheptyl, 2-butyloctyl, 2-pentylnonyl, 2-hexyldecyl, n-dodecyl, n-tetradecyl, n-hexadecyl, n-octadecyl, iso-nonyl, isodecyl, iso-tridecyl and iso-pentadecyl.

**[0100]** Pre-formed peracid: Suitable pre-form peracids include phthalimido-peroxycaproic acid. However, it is preferred that the composition is substantially free of pre-formed peracid. By: "substantially free" it is meant: "no deliberately added".

**[0101]** Enzymes: Suitable enzymes include lipases, proteases, cellulases, amylases and any combination thereof.

**[0102]** Protease: Suitable proteases include metalloproteases and/or serine proteases. Examples of suitable neutral or alkaline proteases include: subtilisins (EC 3.4.21.62); trypsin-type or chymotrypsin-type proteases; and metalloproteases. The suitable proteases include chemically or genetically modified mutants of the aforementioned suitable proteases.

**[0103]** Suitable commercially available protease enzymes include those sold under the trade names Alcalase®, Savinase®, Primase®, Durazym®, Polarzyme®, Kannase®, Liquanase®, Liquanase Ultra®, Savinase Ultra®, Ovozyme®, Neutrase®, Everlase® and Esperase® by Novozymes A/S (Denmark), those sold under the tradename Maxatase®, Maxacal®, Maxapem®, Preferenz P® series of proteases including Preferenz® P280, Preferenz® P281, Preferenz® P2018-C, Preferenz® P2081-WE, Preferenz® P2082-EE and Preferenz® P2083-A/J, Properase®, Purafect®, Purafect Prime®, Purafect Ox®, FN3®, FN4®, Excellase® and Purafect OXP® by DuPont, those sold under the tradename Opticlean® and Optimase® by Solvay Enzymes, those available from Henkel/ Kemira, namely BLAP (sequence shown in Figure 29 of US 5,352,604 with the folowing mutations S99D + S101 R + S103A + V104I + G159S, hereinafter referred to as BLAP), BLAP R (BLAP with S3T + V4I + V199M + V205I + L217D), BLAP X (BLAP with S3T + V4I + V205I) and BLAP F49 (BLAP with S3T + V4I + A194P + V199M + V205I + L217D) - all from Henkel/Kemira; and KAP (Bacillus alkalophilus subtilisin with mutations A230V + S256G + S259N) from Kao.

**[0104]** A suitable protease is described in WO11/140316 and WO11/072117.

**[0105]** Amylase: Suitable amylases are derived from AA560 alpha amylase endogenous to Bacillus sp. DSM 12649, preferably having the following mutations: R118K, D183*, G184*, N195F, R320K, and/or R458K. Suitable commercially available amylases include Stainzyme®, Stainzyme® Plus, Natalase, Termamyl®, Termamyl® Ultra, Liquezyme® SZ, Duramyl®, Everest® (all Novozymes) and Spezyme® AA, Preferenz S® series of amylases, Purastar® and Purastar® Ox Am, Optisize® HT Plus (all Du Pont).

A suitable amylase is described in WO06/002643.

**[0106]** Cellulase: Suitable cellulases include those of bacterial or fungal origin. Chemically modified or protein engi-

neered mutants are also suitable. Suitable cellulases include cellulases from the genera *Bacillus, Pseudomonas, Humicola, Fusarium, Thielavia, Acremonium,* e.g., the fungal cellulases produced from *Humicola insolens, Myceliophthora thermophila* and *Fusarium oxysporum.*

**[0107]** Commercially available cellulases include Celluzyme®, Carezyme®, and Carezyme® Premium, Celluclean® and Whitezyme® (Novozymes A/S), Revitalenz® series of enzymes (Du Pont), and Biotouch® series of enzymes (AB Enzymes). Suitable commercially available cellulases include Carezyme® Premium, Celluclean® Classic. Suitable cellulases are described in WO07/144857 and WO10/056652.

**[0108]** Lipase: Suitable lipases include those of bacterial, fungal or synthetic origin, and variants thereof. Chemically modified or protein engineered mutants are also suitable. Examples of suitable lipases include lipases from *Humicola* (synonym *Thermomyces*), e.g., from *H. lanuginosa* (*T. lanuginosus*).

**[0109]** The lipase may be a "first cycle lipase", e.g. such as those described in WO06/090335 and WO13/116261. In one aspect, the lipase is a first-wash lipase, preferably a variant of the wild-type lipase from Thermomyces lanuginosus comprising T231R and/or N233R mutations. Preferred lipases include those sold under the tradenames Lipex®, Lipolex® and Lipoclean® by Novozymes, Bagsvaerd, Denmark.

**[0110]** Other suitable lipases include: Liprl 139, e.g. as described in WO2013/171241; and TfuLip2, e.g. as described in WO2011/084412 and WO2013/033318.

**[0111]** Other enzymes: Other suitable enzymes are bleaching enzymes, such as peroxidases/oxidases, which include those of plant, bacterial or fungal origin and variants thereof. Commercially available peroxidases include Guardzyme® (Novozymes A/S). Other suitable enzymes include choline oxidases and perhydrolases such as those used in Gentle Power Bleach™.

**[0112]** Other suitable enzymes include pectate lyases sold under the tradenames X-Pect®, Pectaway® (from Novozymes A/S, Bagsvaerd, Denmark) and PrimaGreen® (DuPont) and mannanases sold under the tradenames Mannaway® (Novozymes A/S, Bagsvaerd, Denmark), and Mannastar® (Du Pont).

**[0113]** Identity: When used herein identity or sequence identity refers to the relatedness between two amino acid sequences.

**[0114]** For purposes of the present invention, the degree of sequence identity between two amino acid sequences is determined using the Needleman-Wunsch algorithm (Needleman and Wunsch, 1970, J. Mol. Biol. 48: 443-453) as implemented in the Needle program of the EMBOSS package (EMBOSS: The European Molecular Biology Open Software Suite, Rice et al., 2000, Trends Genet. 16: 276-277), preferably version 3.0.0 or later. The optional parameters used are gap open penalty of 10, gap extension penalty of 0.5, and the EBLOSUM62 (EMBOSS version of BLOSUM62) substitution matrix. The output of Needle labeled "longest identity" (obtained using the -nobrief option) is used as the percent identity and is calculated as follows:

$$\text{(Identical Residues x 100)/(Length of Alignment – Total Number of Gaps in Alignment).}$$

**[0115]** Brightener: Suitable fluorescent brighteners include: di-styryl biphenyl compounds, e.g. Tinopal® CBS-X, diamino stilbene di-sulfonic acid compounds, e.g. Tinopal® DMS pure Xtra and Blankophor® HRH, and Pyrazoline compounds, e.g. Blankophor® SN, and coumarin compounds, e.g. Tinopal® SWN.

Preferred brighteners 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-sulfostyryl)biphenyl. A suitable fluorescent brightener is C.I. Fluorescent Brightener 260, which may be used in its beta or alpha crystalline forms, or a mixture of these forms.

**[0116]** Hueing agent: Suitable hueing agents include small molecule dyes, typically falling into the Colour Index (C.I.) classifications of Acid, Direct, Basic, Reactive (including hydrolysed forms thereof) or Solvent or Disperse dyes, for example classified as Blue, Violet, Red, Green or Black, and provide the desired shade either alone or in combination. Preferred such hueing agents include Acid Violet 50, Direct Violet 9, 66 and 99, Solvent Violet 13 and any combination thereof.

**[0117]** Many hueing agents are known and described in the art which may be suitable for the present invention, such as hueing agents described in WO2014/089386.

**[0118]** Suitable hueing agents include phthalocyanine and azo dye conjugates, such as described in WO2009/069077.

**[0119]** Suitable hueing agents may be alkoxylated. Such alkoxylated compounds may be produced by organic synthesis that may produce a mixture of molecules having different degrees of alkoxylation. Such mixtures may be used directly to provide the hueing agent, or may undergo a purification step to increase the proportion of the target molecule. Suitable hueing agents include alkoxylated bis-azo dyes, such as described in WO2012/054835, and/or alkoxylated thiophene azo dyes, such as described in WO2008/087497 and WO2012/166768.

**[0120]** The hueing agent may be incorporated into the detergent composition as part of a reaction mixture which is

the result of the organic synthesis for a dye molecule, with optional purification step(s). Such reaction mixtures generally comprise the dye molecule itself and in addition may comprise un-reacted starting materials and/or by-products of the organic synthesis route. Suitable hueing agents can be incorporated into hueing dye particles, such as described in WO 2009/069077.

**[0121]** Reserve alkalinity: Typically, the composition at 1wt% dilution in deionized water at 20°C, has a reserve alkalinity to pH 7.5 of less than 3.0gNaOH/100g, preferably less than 2.5gNaOH/100g, or even less than 2.0gNaOH/100g.

**[0122]** As used herein, the term "reserve alkalinity" is a measure of the buffering capacity of the detergent composition (g/NaOH/100g detergent composition) determined by titrating a 1% (w/v) solution of detergent composition with hydrochloric acid to pH 7.5 i.e. in order to calculate Reserve Alkalinity as defined herein:

$$\text{Reserve Alkalinity (to pH 7.5) as \% alkali in g NaOH/100 g product} = \frac{T \times M \times 40 \times Vol}{10 \times Wt \times Aliquot}$$

| | |
|---|---|
| T | = titre (ml) to pH 7.5 |
| M | = Molarity of HCl = 0.2 |
| 40 | = Molecular weight of NaOH |
| Vol | = Total volume (ie. 1000 ml) |
| W | = Weight of product (10 g) |
| Aliquot | = (100 ml) |

**[0123]** Obtain a 10g sample accurately weighed to two decimal places, of fully formulated detergent composition. The sample should be obtained using a Pascall sampler in a dust cabinet. Add the 10g sample to a plastic beaker and add 200 ml of carbon dioxide-free de-ionised water. Agitate using a magnetic stirrer on a stirring plate at 150 rpm until fully dissolved and for at least 15 minutes. Transfer the contents of the beaker to a 1 litre volumetric flask and make up to 1 litre with deionised water. Mix well and take a 100 mls ± 1 ml aliquot using a 100 mls pipette immediately. Measure and record the pH and temperature of the sample using a pH meter capable of reading to ±0.01pH units, with stirring, ensuring temperature is 20°C +/- 2°C. Titrate whilst stirring with 0.2M hydrochloric acid until pH measures exactly 7.5. Note the millilitres of hydrochloric acid used. Take the average titre of three identical repeats. Carry out the calculation described above to calculate the reserve alkalinity to pH 7.5.

EXAMPLES

**[0124]** Finite Elements Analysis (FEA) simulations of the particle flow in a testing device Flodex™ (Hanson research, Chatsworth, CA, USA) have been perfomed in LS-DYNA commercial software (version R8.0, Livermore Software Technology Corp.). Flodex™ is a flat-bottom cylindrical silo with changeable orifice openings. All bodies in these simulations are assumed to be rigid solids, and the shape of each body is defined via a surface mesh. Simulation results are post-processed to assess discharge rates out of the defined orifice.

**[0125]** Procedure to conduct the simulations is as follows:

(1) Exporting geometry definition files. Create geometry files for the cylindrical hopper, a hopper bottom with specified orifice size, and a stopper in Solid Edge or similar CAD program and save to IGS or STP format. For each geometry file, import the file into LS-PrePost (Livermore Software Technology Corp.) and use the automeshing capability to apply a surface mesh to the part. Renumber the parts in order 1-3, avoiding repetition. Renumber the elements and nodes in each part to order them and avoid repetition. Save each part file to a .k keyword file.

- To renumber the nodes, pick an arbitrary number as a starting point for the nodes in each part such that it ensures node ID's are not repeated. For example, if part 1 has ~5,000 nodes, start renumbering the nodes of part 2 at 10,000, and so on. Follow the same procedure for renumbering the elements of each part.
- Using a text editor or similar utility, remove the five lines of the part description from the individual keyword files. The part declarations will be done in the main input file.

(2) Creating particle definition files. Create a geometry file for the particle(s) of interest using Solid Edge or similar CAD program and save to IGS or STP format. For each particle file, import the file into LS-PrePost and use the automeshing capability to apply a surface mesh to the part. Renumber the part to #4. Renumber the elements and nodes in the particle to avoid repetition. Save to a .k keyword file, particle.k.

(3) Establishing input files. The simulation is driven using standard LS-DYNA commands for manipulating rigid parts through time. The unique aspect to the simulation is that we autogenerate a large set of parts, nodes, and elements that

represent the distinct particles used in the simulation. We also automatically generate supporting files that describe a time series of events to occur during the simulation.

- Using a program, for example FORTRAN, the instructions to generate particles can be automated according to the following steps: particles are created in a series of 8 sets. Each set is identical and is composed of 500 randomly oriented and located particles. A set is created using a random sequential addition algorithm in which we first insert a set of 500 spheres with diameter equal to the particle ferret diameter and ensure that no overlaps exist between the spheres. The spheres are inserted into a specified region of space directly above the cylindrical hopper. A particle is then randomly oriented and placed within each inserted sphere. Part, node, and element sequencing is automatically generated via the program.
- Particle sets are identical except for initial position. The particle sets are positioned in a row above the cylindrical hopper, with only the first set directly above the hopper. All particle sets except the set directly above the hopper are frozen in place. A sequence of timing commands is included in the input files so that once a set of particles has had sufficient time to vacate the insertion region while acted upon by gravity, the next set of particles is moved into the insertion region and unfrozen so that they may also fall into the hopper.
- A final event is specified to allow for removal of the plug at the bottom of the hopper to initiate flow. The plug is moved downward, out of the orifice and to a distance sufficiently far from the cylinder so as to not inhibit particle flow, over the span of a single timestep.

The following table summarizes the parameters used for current simulations.

*Table 1. Settings for particle creation*

| Parameter | Values |
|---|---|
| Number of particles inserted | 4000 |
| Number of particles per set | 500 |
| Number of sets | 8 |
| Insertion volume dimensions | Cylinder radius: 27 mm, height 49.05 mm |
| Falling distance | 100mm |

(4) Displacing the plug and calculating the discharge rates. Calculate the occupied volume within the upper cylinder for the bulk density.

**[0126]** Simulated shapes are included in Figure 1.

**[0127]** Flodex™ geometry file is imported from CAD files generated using Solid Edge ST9. The geometry element parameters used for these simulations are summarized in Table 2.

*Table 2 Flodex™ Geometry simulation parameters.*

| | Values | Unit s |
|---|---|---|
| Diameter | 5.7 | cm |
| Height | 10 | cm |
| Orifice diameter | 4.0 | cm |

**[0128]** Once input files are generated and initialization is done, simulation time, frequency of data sampling and material properties for the particles must be included in the input deck (input.k). Parameters are summariezed in Tables 3 and 4. Plug out time indicates the time at which the plug is removed and the particles are allowed to flow down. Material properties considered in the simulations are characteristic of compositions:

(a) from 20wt% to 59wt% detersive surfactant selected from anionic detersive surfactant and/or non-ionic detersive surfactant;
(b) from 10wt% to 40wt% inorganic salts selected from sodium carbonate, sodium sesquicarbonate, sodium bicarbonate and any mixtures thereof;
(c) optionally, from 10wt% to 40wt% citric acid and/or salts thereof;

wherein the detersive surfactant comprises from 51wt% to 100wt% alkyl benzene sulphonate, wherein the coating comprises the inorganic salt (b), and wherein the core comprises the detersive surfactant (a).

*Table 3. Material properties used in the simulations*

| | | |
|---|---|---|
| Density | 1000 | kg/m^ 3 |
| Young's modulus | 1e7-1e9 | Pa |
| Poison ratio | 0.20-0.30 | |
| Static Coefficient of friction | 0.5 | |
| Viscous damping coefficient | 50.0 | % |
| Exponential decay coefficient | 0 | |

*Table 4. Simulation events.*

| | |
|---|---|
| Total time | 5 (s) |
| Plug out time after filling | 1.5 (s) |
| Frequency of data sampling | 0.1 (s) |

**[0129]** Three different particle shapes with similar volume and aspect ratio have been assessed, one corresponding to a non-distorted oblate and two other particles having a distorted oblate spheroidal shape. Particle shape parameters are included in table 5.

*Table 5. Particle properties.*

| Simulation ID | O_50_AI_05 Comparative | DO_32_AI_05 Invention | DO_14_AI_05 Invention |
|---|---|---|---|
| y or z dimension [mm] | 5.00 | 5.00 | 5.00 |
| x dimension [mm] | 1.1 | 1.1 | 1.1 |
| Height top half particle [mm] | 0.55 | 0.75 | 0.95 |
| Height bottom half particle [mm] | 0.55 | 0.35 | 0.15 |
| Particle aspect ratio | 0.22 | 0.22 | 0.22 |
| Volume ratio | *1.00* | 2.14 | 6.33 |
| Surface particle [$mm^2$], (S) | 43.55 | 43.77 | 44.47 |
| Volume particle [$mm^3$], (V) | 14.43 | 14.40 | 14.40 |
| Surface/Volume of particle [$mm^{-1}$], (S/V) | *3.02* | *3.04* | *3.09* |
| Volume top half particle [$mm^3$] | 7.21 | 9.82 | 12.43 |
| Volume bottom half particle [$m^2$] | 7.21 | 4.58 | 1.96 |
| Surface top half particle [$m^2$] | 21.78 | 23.10 | 24.60 |
| Surface bottom half particle [$m^2$] | 21.78 | 20.67 | 19.88 |
| Surface/Volume ratio Top half particle [mm] | 3.02 | 2.35 | 1.98 |
| Surface/Volume ratio Bottom half particle [mm] | 3.02 | 4.51 | 10.12 |
| Half of the greater of y or z [mm], (a) | 2.50 | 2.50 | 2.50 |
| Half of the greater of x [mm], (b) | 0.55 | 0.55 | 0.55 |
| Eccentricity [mm], (e) | 0.98 | 0.98 | 0.98 |
| Linear Eccentricity [mm], (c) | 2.44 | 2.44 | 2.44 |

(continued)

| Simulation ID | O_50_AI_05 Comparative | DO_32_AI_05 Invention | DO_14_AI_05 Invention |
|---|---|---|---|
| Semi lactus rectum [mm], (p) | *0.12* | *0.12* | *0.12* |
| Greatest of the half height particle at radius equal to linear eccentricity [mm], (h) | *0.12* | *0.16* | *0.21* |
| Surface to volume ratio of a non distorted spherical oblate for given aspect ratio [$mm^{-1}$], (N/L) | *3.02* | *3.02* | *3.02* |
| Greatest S/V of half particle in y-z plane, [mm] | *3.02* | *4.51* | *10.12* |

**[0130]** Results of LS-Dyna simulations were analyzed in LS-PrePost. LS-PrePost outputs the positions of all nodes within the simulation. Position of the particles can be inferred at any time from the position of the corresponding nodes. Discharge rate can be calculated by plotting the number of particles bellow the orifice position at any time. Average discharge rate has been estimated from the slope of the graph between number of particles discharged vs time (Figure 2).

**[0131]** A characteristic discharge rate for the system can be estimated by calculating the slope of the points when between 1000-3000 particles so onset and final discharge effects are removed.

**[0132]** Discharge rate values for these conditions are included in Table 6:

*Table 6. Characteristic discharge rates of particles.*

| Simulation ID | O_50_AI_05 Comparative | DO_32_AI_05 Invention | DO_14_AI_05 Invention |
|---|---|---|---|
| Discharge rate [particles/s] | 6550 | 3963 | 3725 |
| Discharge rate [g/s] | 95 | 57 | 54 |

**[0133]** Differences in the the discharge rate between the comparative and the invention examples are significant to enable a higher level dosing control, especially when pouring the particles from a bottle container.

**[0134]** The dimensions and values disclosed herein are not to be understood as being strictly limited to the exact numerical values recited. Instead, unless otherwise specified, each such dimension is intended to mean both the recited value and a functionally equivalent range surrounding that value. For example, a dimension disclosed as "40 mm" is intended to mean "about 40 mm."

SEQUENCE LISTING

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<120> LAUNDRY DETERGENT COMPOSITION

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Leu Pro Asn Asp Gly Asn His Trp Asn Arg Leu Asn Ser Asp Ala Ser
            20                  25                  30

Asn Leu Lys Ser Lys Gly Ile Thr Ala Val Trp Ile Pro Pro Ala Trp
        35                  40                  45

Lys Gly Ala Ser Gln Asn Asp Val Gly Tyr Gly Ala Tyr Asp Leu Tyr
    50                  55                  60

Asp Leu Gly Glu Phe Asn Gln Lys Gly Thr Val Arg Thr Lys Tyr Gly
```

65 70 75 80

Thr Arg Ser Gln Leu Gln Ala Ala Val Thr Ser Leu Lys Asn Asn Gly
85 90 95

Ile Gln Val Tyr Gly Asp Val Val Met Asn His Lys Gly Gly Ala Asp
100 105 110

Ala Thr Glu Met Val Arg Ala Val Glu Val Asn Pro Asn Asn Arg Asn
115 120 125

Gln Glu Val Thr Gly Glu Tyr Thr Ile Glu Ala Trp Thr Arg Phe Asp
130 135 140

Phe Pro Gly Arg Gly Asn Thr His Ser Ser Phe Lys Trp Arg Trp Tyr
145 150 155 160

His Phe Asp Gly Val Asp Trp Asp Gln Ser Arg Arg Leu Asn Asn Arg
165 170 175

Ile Tyr Lys Phe Arg Gly His Gly Lys Ala Trp Asp Trp Glu Val Asp
180 185 190

Thr Glu Asn Gly Asn Tyr Asp Tyr Leu Met Tyr Ala Asp Ile Asp Met
195 200 205

Asp His Pro Glu Val Val Asn Glu Leu Arg Asn Trp Gly Val Trp Tyr
210 215 220

Thr Asn Thr Leu Gly Leu Asp Gly Phe Arg Ile Asp Ala Val Lys His
225 230 235 240

Ile Lys Tyr Ser Phe Thr Arg Asp Trp Ile Asn His Val Arg Ser Ala
245 250 255

Thr Gly Lys Asn Met Phe Ala Val Ala Glu Phe Trp Lys Asn Asp Leu
260 265 270

Gly Ala Ile Glu Asn Tyr Leu Gln Lys Thr Asn Trp Asn His Ser Val
275 280 285

Phe Asp Val Pro Leu His Tyr Asn Leu Tyr Asn Ala Ser Lys Ser Gly
290 295 300

Gly Asn Tyr Asp Met Arg Asn Ile Phe Asn Gly Thr Val Val Gln Arg
305 310 315 320

```
His Pro Ser His Ala Val Thr Phe Val Asp Asn His Asp Ser Gln Pro
                325                 330                 335

Glu Glu Ala Leu Glu Ser Phe Val Glu Glu Trp Phe Lys Pro Leu Ala
            340                 345                 350

Tyr Ala Leu Thr Leu Thr Arg Glu Gln Gly Tyr Pro Ser Val Phe Tyr
        355                 360                 365

Gly Asp Tyr Tyr Gly Ile Pro Thr His Gly Val Pro Ala Met Arg Ser
    370                 375                 380

Lys Ile Asp Pro Ile Leu Glu Ala Arg Gln Lys Tyr Ala Tyr Gly Pro
385                 390                 395                 400

Gln His Asp Tyr Ile Asp His Pro Asp Val Ile Gly Trp Thr Arg Glu
                405                 410                 415

Gly Asp Ser Ser Ala Ala Lys Ser Gly Leu Ala Ala Leu Ile Thr Asp
            420                 425                 430

Gly Pro Gly Gly Ser Lys Arg Met Tyr Ala Gly Leu Lys Asn Ala Gly
        435                 440                 445

Glu Thr Trp Tyr Asp Ile Thr Gly Asn Arg Ser Asp Thr Val Lys Ile
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Gly Ser Asp Gly Trp Gly Glu Phe His Val Asn Asp Gly Ser Val Ser
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Ile Tyr Val Gln Lys
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            20                  25                  30

Asn Ile Thr Cys Thr Gly Asn Ala Cys Pro Glu Val Glu Lys Ala Asp
        35                  40                  45
```

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Ala Thr Phe Leu Tyr Ser Phe Glu Asp Ser Gly Val Gly Asp Val Thr
    50                  55                  60

Gly Phe Leu Ala Leu Asp Asn Thr Asn Lys Leu Ile Val Leu Ser Phe
65                  70                  75                  80

Arg Gly Ser Arg Ser Ile Glu Asn Trp Ile Gly Asn Leu Asn Phe Asp
                85                  90                  95

Leu Lys Glu Ile Asn Asp Ile Cys Ser Gly Cys Arg Gly His Asp Gly
            100                 105                 110

Phe Thr Ser Ser Trp Arg Ser Val Ala Asp Thr Leu Arg Gln Lys Val
        115                 120                 125

Glu Asp Ala Val Arg Glu His Pro Asp Tyr Arg Val Val Phe Thr Gly
    130                 135                 140

His Ser Leu Gly Gly Ala Leu Ala Thr Val Ala Gly Ala Asp Leu Arg
145                 150                 155                 160

Gly Asn Gly Tyr Asp Ile Asp Val Phe Ser Tyr Gly Ala Pro Arg Val
                165                 170                 175

Gly Asn Arg Ala Phe Ala Glu Phe Leu Thr Val Gln Thr Gly Gly Thr
            180                 185                 190

Leu Tyr Arg Ile Thr His Thr Asn Asp Ile Val Pro Arg Leu Pro Pro
        195                 200                 205

Arg Glu Phe Gly Tyr Ser His Ser Ser Pro Glu Tyr Trp Ile Lys Ser
    210                 215                 220

Gly Thr Leu Val Pro Val Thr Arg Asn Asp Ile Val Lys Ile Glu Gly
225                 230                 235                 240

Ile Asp Ala Thr Gly Gly Asn Asn Gln Pro Asn Ile Pro Asp Ile Pro
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Ala His Leu Trp Tyr Phe Gly Leu Ile Gly Thr Cys Leu
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            20                  25                  30

Asn Thr Arg Gly Asn Gly Ile Phe Thr Tyr Asp Ala Lys Tyr Arg Thr
        35                  40                  45

Thr Leu Pro Gly Ser Leu Trp Ala Asp Ala Asp Asn Gln Phe Phe Ala
    50                  55                  60

Ser Tyr Asp Ala Pro Ala Val Asp Ala His Tyr Tyr Ala Gly Val Thr
65                  70                  75                  80

Tyr Asp Tyr Tyr Lys Asn Val His Asn Arg Leu Ser Tyr Asp Gly Asn
                85                  90                  95

Asn Ala Ala Ile Arg Ser Ser Val His Tyr Ser Gln Gly Tyr Asn Asn
            100                 105                 110

Ala Phe Trp Asn Gly Ser Gln Met Val Tyr Gly Asp Gly Asp Gly Gln
        115                 120                 125

Thr Phe Ile Pro Leu Ser Gly Gly Ile Asp Val Val Ala His Glu Leu
    130                 135                 140

Thr His Ala Val Thr Asp Tyr Thr Ala Gly Leu Ile Tyr Gln Asn Glu
145                 150                 155                 160

Ser Gly Ala Ile Asn Glu Ala Ile Ser Asp Ile Phe Gly Thr Leu Val
                165                 170                 175

Glu Phe Tyr Ala Asn Lys Asn Pro Asp Trp Glu Ile Gly Glu Asp Val
            180                 185                 190

Tyr Thr Pro Gly Ile Ser Gly Asp Ser Leu Arg Ser Met Ser Asp Pro
        195                 200                 205

Ala Lys Tyr Gly Asp Pro Asp His Tyr Ser Lys Arg Tyr Thr Gly Thr
    210                 215                 220

Gln Asp Asn Gly Gly Val His Ile Asn Ser Gly Ile Ile Asn Lys Ala
225                 230                 235                 240

Ala Tyr Leu Ile Ser Gln Gly Gly Thr His Tyr Gly Val Ser Val Val
                245                 250                 255
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Gly Ile Gly Arg Asp Lys Leu Gly Lys Ile Phe Tyr Arg Ala Leu Thr
260 265 270

Gln Tyr Leu Thr Pro Thr Ser Asn Phe Ser Gln Leu Arg Ala Ala Ala
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Val Gln Ser Ala Thr Asp Leu Tyr Gly Ser Thr Ser Gln Glu Val Ala
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Ser Val Lys Gln Ala Phe Asp Ala Val Gly Val Lys
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20 25 30

Lys Pro Thr Gly Thr Gln Ile Ile Thr Tyr Asp Leu Gln Asn Arg Glu
35 40 45

Tyr Asn Leu Pro Gly Thr Leu Val Ser Ser Thr Thr Asn Gln Phe Thr
50 55 60

Thr Ser Ser Gln Arg Ala Ala Val Asp Ala His Tyr Asn Leu Gly Lys
65 70 75 80

Val Tyr Asp Tyr Phe Tyr Gln Lys Phe Asn Arg Asn Ser Tyr Asp Asn
85 90 95

Lys Gly Gly Lys Ile Val Ser Ser Val His Tyr Gly Ser Arg Tyr Asn
100 105 110

Asn Ala Ala Trp Ile Gly Asp Gln Met Ile Tyr Gly Asp Gly Asp Gly
115 120 125

Ser Phe Phe Ser Pro Leu Ser Gly Ser Met Asp Val Thr Ala His Glu
130 135 140

Met Thr His Gly Val Thr Gln Glu Thr Ala Asn Leu Asn Tyr Glu Asn
145 150 155 160

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Gln Pro Gly Ala Leu Asn Glu Ser Phe Ser Asp Val Phe Gly Tyr Phe
                165                 170                 175

Asn Asp Thr Glu Asp Trp Asp Ile Gly Glu Asp Ile Thr Val Ser Gln
            180                 185                 190

Pro Ala Leu Arg Ser Leu Ser Asn Pro Thr Lys Tyr Gly Gln Pro Asp
        195                 200                 205

Asn Phe Lys Asn Tyr Lys Asn Leu Pro Asn Thr Asp Ala Gly Asp Tyr
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Ala Leu Thr Val Tyr Leu Thr Pro Ser Ser Thr Phe Lys Asp Ala Lys
            260                 265                 270

Ala Ala Leu Ile Gln Ser Ala Arg Asp Leu Tyr Gly Ser Gln Asp Ala
        275                 280                 285

Ala Ser Val Glu Ala Ala Trp Asn Ala Val Gly Leu
    290                 295                 300
```

## Claims

1. A coated detergent particle having a distorted oblate spheroidal shape with perpendicular dimensions x, y and z, wherein x is from 1 to 2 mm, y is from 2 to 8mm, and z is from 2 to 8 mm, wherein the particle comprises:

   (a) from 20wt% to 59wt% detersive surfactant selected from anionic detersive surfactant and/or non-ionic detersive surfactant;
   (b) from 10wt% to 40wt% inorganic salts selected from sodium carbonate, sodium sesquicarbonate, sodium bicarbonate and any mixtures thereof;
   (c) optionally, from 10wt% to 40wt% citric acid and/or salts thereof;

   wherein the detersive surfactant comprises from 51wt% to 100wt% alkyl benzene sulphonate,
   wherein the coating comprises the inorganic salt (b), and wherein the core comprises the detersive surfactant (a),
   wherein the oblate spheroidal shape is distorted such that the ratio of the surface area (S) to volume (V) of the particle is different to the value of NL,

$$S / V \neq NL$$

   wherein NL is defined as:

$$NL = \frac{3}{2b} + \frac{3b}{4\epsilon a^2} ln\left(\frac{1+\epsilon}{1-\epsilon}\right)$$

wherein a = is half of the greater of y or z (long radius of the oblate)
b = half of the dimension x (short radius of the oblate)
$\varepsilon$ = the eccentricity,

wherein

$$\epsilon = \sqrt{1 - \frac{b^2}{a^2}}$$

**2.** A particle according to claim 1, wherein the oblate spheroidal shape of the particle is distorted such that the ratio of the surface area (S) to volume (V) of the particle is greater than NL multiplied by 1.005,

$$S / V > NL \text{ x } 1.005.$$

**3.** A particle according to claim 1, wherein the oblate spheroidal shape of the particle is distorted such that the ratio of the surface area (S) to volume (V) of the particle is less than NL multiplied by 0.99,

$$S / V < NL \text{ x } 0.99.$$

**4.** A particle according to any preceding claim, wherein the oblate spheroidal shape of the particle is distorted such that at the radius equal to the linear eccentricity (c), the greatest of the half height of the particle (h) in the x-plane is greater than the semi latus rectum (p),

$$h > p$$

wherein

$$p = \frac{b^2}{a}$$

$$c = \sqrt{a^2 - b^2}$$

**5.** A particle according to claim 4, wherein the oblate spheroidal shape of the particle is distorted such that at the radius equal to the linear eccentricity (c), the greatest of the half height of the particle (h) in the x-plane is greater than the lactus rectum (*p*) multiplied by 1.05,

$$h > p \text{ x } 1.05.$$

**6.** A particle according to claim 4, wherein the volume ratio of the particle is above 1, where volume ratio is defined as the ratio of (i) the greater volume of the particle to one size of the y-z plane to (ii) the lesser volume of the particle to the other side of the y-z plane.

**7.** Particle according to any preceding claim, wherein the particle has an average surface roughness (Ra) of less than 6.0$\mu$m.

8. A particle according to any preceding claim, wherein the particle has a coefficient of friction in the range of from 0.2 to 0.5.

9. A particle according to any preceding claim, wherein at 1wt% dilution in de-ionised water at 20°C, the composition has a pH in the range of from 7.6 to 10.0.

10. A particle according to any preceding claim, wherein at 1wt% dilution in de-ionised water at 20°C, the composition has a reserve alkalinity to pH 7.5 of greater than 3.0.

Figure 1. Shapes simulated. Undistorted oblate spheroidal shape particle O_50_AI_05 Comparative and distorted oblate spherical shape particles DO_32_AI_05, DO_14_AI_05 (Invention).

| | | |
|---|---|---|
| | | |
| | | |
| | | |

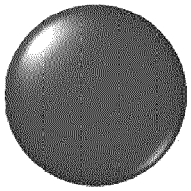
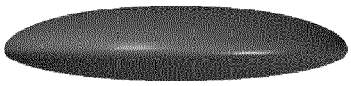
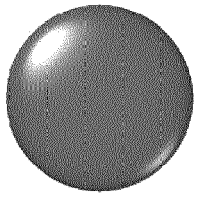
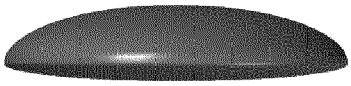
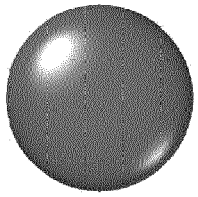
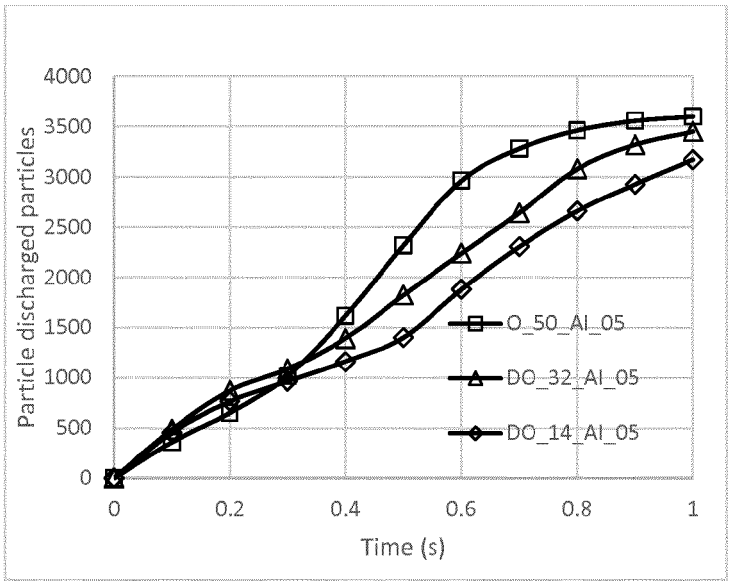
| | Side view | Top view |
|---|---|---|
| O_50_AI_05 |  |  |
| DO_32_AI_05 |  |  |
| DO_14_AI_05 |  |  |

Figure 2 Discharge rate curves for the simulations of undistorted oblate spheroidal shape particle O_50_AI_05 (comparative) distorted oblate spherical shape particles DO_32_AI_05, DO_14_AI_05 (Invention) on a Flodex™ with an orifice of 40 mm.



Europäisches Patentamt
European Patent Office
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# EUROPEAN SEARCH REPORT

Application Number
EP 17 20 8549

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| X | WO 2013/139702 A1 (UNILEVER PLC [GB]; UNILEVER NV [NL]; CONOPCO INC DBA UNILEVER [US]) 26 September 2013 (2013-09-26)<br>* page 18, line 1 - page 21, line 4; claims; examples *<br>----- | 1-10 | INV.<br>C11D3/10<br>C11D3/386<br>C11D17/00 |
| X,D | WO 2010/122050 A2 (UNILEVER PLC [GB]; UNILEVER NV [NL]; UNILEVER HINDUSTAN [IN]; CHAMBERS) 28 October 2010 (2010-10-28)<br>* page 16, line 20 - page 21, line 3 *<br>* page 11, line 15 - line 18 *<br>----- | 1-10 | |

TECHNICAL FIELDS SEARCHED (IPC)

C11D

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 2 February 2018 | Vernier, Frédéric |

CATEGORY OF CITED DOCUMENTS

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L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 20 8549

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02-02-2018

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| WO 2013139702 A1 | 26-09-2013 | AR 090436 A1 | 12-11-2014 |
| | | WO 2013139702 A1 | 26-09-2013 |
| WO 2010122050 A2 | 28-10-2010 | AR 076395 A1 | 08-06-2011 |
| | | AU 2010240944 A1 | 03-11-2011 |
| | | BR PI1014899 A2 | 19-04-2016 |
| | | CA 2759825 A1 | 28-10-2010 |
| | | CN 102414305 A | 11-04-2012 |
| | | EP 2421949 A2 | 29-02-2012 |
| | | ES 2473967 T3 | 08-07-2014 |
| | | MY 155571 A | 30-10-2015 |
| | | US 2012058266 A1 | 08-03-2012 |
| | | WO 2010122050 A2 | 28-10-2010 |
| | | ZA 201107439 B | 27-12-2012 |

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

## REFERENCES CITED IN THE DESCRIPTION

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- WO 2007044993 A **[0076]**
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- US 5352604 A **[0103]**
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- WO 2012166768 A **[0119]**


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- **NEEDLEMAN ; WUNSCH.** *J. Mol. Biol.,* 1970, vol. 48, 443-453 **[0114]**
- **RICE et al.** EMBOSS: The European Molecular Biology Open Software Suite. *Trends Genet.,* 2000, vol. 16, 276-277 **[0114]**