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(54) Title: IMPROVED LIGHT-DUTY LIQUID PERFORMANCE OF ETHER SULFATE USING ALKYL POLYGLYCOSIDE

(57) Abstract

A process for enhancing the foam stability of an aqueous cleaning composition involving the steps of: (a) providing a surfactant composition consisting essentially of: (i) an alkyl ether sulfate having from 1 to about 4 moles of ethylene oxide; and (ii) an alkyl polyglycoside of formula (I): $R_1O(R_2O)_b(Z)_a$, wherein R_1 is a monovalent organic radical having from about 6 to about 30 carbon atoms; R_2 is a divalent alkylene radical having from 2 to 4 carbon atoms; Z is a saccharide residue having 5 or 6 carbon atoms; b is a number having a value from 0 to about 12; a is a number having a value from 1 to about 6, wherein components (a)(i) and (a)(ii), respectively, are combined in a percent actives ratio ranging from 1:1 to about 4:1; (b) providing a foam stabilizer selected from the group consisting of a betaine, an alkanolamide, an amine oxide, and mixtures thereof; (c) providing a water component and combining components (a)–(c) to form the aqueous cleaning composition.

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IMPROVED LIGHT-DUTY LIQUID PERFORMANCE OF ETHER SULFATE USING ALKYL POLYGLYCOSIDE

Field of the Invention:

The present invention generally relates to enhancing the foam stability of light-duty liquid compositions. More particularly, by employing a surfactant mixture containing an alkyl ether sulfate and an alkyl polyglycoside, the foam stability of known foam stabilizer compositions can be enhanced.

Background of the Invention:

It is known that various surfactants have been found to be useful in cleaning compositions, such as shower gels, shampoos, and light duty detergents such as dish washing detergents. In these types of compositions, good foamability is a prerequisite. The most widely used surfactants in these types of compositions are anionic surfactants such as alkyl sulfates, alkyl ether sulfates, sulfonates, sulfosuccinates and sarcosinates.

Although the use of anionic surfactants in these compositions permits the attainment of desirable properties, including good foamability, the degree of foam stability leaves much to be desired. Foam stability relates to the ability of the foam, once formed, to remain intact for extended periods of time in the presence of varying amounts of soil, thus enhancing the cleaning

performance of the surfactant compositions.

It is sometimes advantageous to use foam stabilizers which are mixtures of surfactants in cleaning compositions when the surfactants can serve different functions, e.g., one serving to improve foamability and another serving to adjust viscosity. However, known surfactant mixtures typically provide a compromise between what can be achieved with the surfactant ingredients alone. For example, a mixture of more costly surfactants such as amine oxides, betaines and alkanolamides which provide good foamability by themselves, with less expensive surfactants such as alkyl ether sulfonates, which provide poorer foamability, will result in the formulation of a cleaning composition having an intermediate degree of foamability and poor foam stability.

It is therefore an object of the present invention to determine a way in which to enhance the foam stability of inexpensive and ineffective surfactants.

Summary of the Invention:

The present invention is directed to a process for making a cleaning composition having enhanced foam stability involving the steps of:

(a) providing a surfactant mixture consisting essentially of:

(i) an alkyl ether sulfate having from 1 to about 4 ethylene oxide moieties; and

(ii) an alkyl polyglycoside of formula I:

$$R_1O(R_2O)_b(Z)_a \qquad I$$

wherein R_1 is a monovalent organic radical having from about 6 to about 30 carbon atoms; R_2 is divalent alkylene radical having from 2 to 4 carbon atoms; Z is a saccharide residue having 5 or 6 carbon atoms; b is a number having a value from 0 to about 12; a is a number having a value from 1 to about 6, wherein components (a)(i) and (a)(ii), respectively, are combined in a percent actives ratio ranging from 1:1 to about 4:1;

(b) providing a foam stabilizer selected from the group consisting of a betaine, an alkanolamide, an amine oxide, and mixtures thereof; and

(c) combining components (a) and (b) to form a cleaning composition having enhanced foam stability.

The present invention is also directed to a cleaning composition having enhanced foam stability properties consisting essentially of:

(a) a surfactant mixture consisting essentially of:

(i) an alkyl ether sulfate having from 1 to about 4 moles of ethylene oxide; and

(ii) an alkyl polyglycoside of formula I:

$$R_1O(R_2O)_b(Z)_a \qquad I$$

wherein R_1 is a monovalent organic radical having from about 6 to about 30 carbon atoms; R_2 is divalent alkylene radical having from 2 to 4 carbon atoms; Z is a saccharide residue having 5 or 6 carbon atoms; b is a number having a value from 0 to about 12; a is a number having a value from 1 to about 6, wherein components (a)(i) and (a)(ii), respectively, are combined in a ratio by weight of from about 1:1 to about 4:1; and

(b) a foam stabilizer selected from the group consisting of a betaine, an alkanolamide, an amine oxide, and mixtures thereof.

Description of the Invention:

Other than in the operating examples, or where otherwise indicated, all numbers expressing quantities of ingredients or reaction conditions used herein are to be understood as being modified in all instances by the term "about".

THE SURFACTANT MIXTURE

Alkyl ether sulfates are generally defined as salts of sulfated adducts of ethylene oxide with fatty alcohols containing from about 10 to about 18 carbon atoms. The alkyl ether sulfates employed in the present invention are commercially available and contain a linear aliphatic group

having from about 8 to about 18 carbon atoms, and preferably from about 12 to about 14 carbon atoms. The degree of ethoxylation is from 1 to about 4 moles of ethylene oxide, and preferably about 3 moles of ethylene oxide. A particularly preferred alkyl ether sulfate for use in the present invention is sodium lauryl ether sulfate.

The alkyl polyglycosides which can be used in the surfactant mixture according to the present invention have the general formula I:

$$R_1O(R_2O)_b(Z)_a \qquad I$$

wherein R_1 is a monovalent organic radical having from about 6 to about 30 carbon atoms; R_2 is a divalent alkylene radical having from 2 to 4 carbon atoms; Z is a saccharide residue having 5 or 6 carbon atoms; b is a number having a value from 0 to about 12; a is a number having a value from 1 to about 6. Preferred alkyl polyglycosides which can be used in the compositions according to the invention have the formula I wherein Z is a glucose residue and b is zero. Such alkyl polyglycosides are commercially available, for example, as APG®, GLUCOPON®, or PLANTAREN® surfactants from Henkel Corporation, Ambler, PA 19002. Examples of such surfactants include but are not limited to:

1. APG® 225 Surfactant - an alkyl polyglycoside in which the alkyl group contains 8 to 10 carbon atoms and having an average degree of polymerization of 1.7.
2. APG® 425 Surfactant - an alkyl polyglycoside in which the alkyl group contains 8 to 16 carbon atoms and having an average degree of polymerization of 1.6.
3. APG® 625 Surfactant - an alkyl polyglycoside in which the alkyl group contains 12 to 16 carbon atoms and having an average degree of polymerization of 1.6.
4. APG® 325 Surfactant - an alkyl polyglycoside in which the alkyl group contains 9 to 11 carbon atoms and having an average degree of polymerization of 1.6.
5. GLUCOPON® 600 Surfactant - an alkyl polyglycoside in which the alkyl group contains 12 to 16 carbon atoms and

having an average degree of polymerization of 1.4.

6. PLANTAREN® 2000 Surfactant - a C_{8-16} alkyl polyglycoside in which the alkyl group contains 8 to 16 carbon atoms and having an average degree of polymerization of 1.4.

7. PLANTAREN® 1300 Surfactant - a C_{12-16} alkyl polyglycoside in which the alkyl group contains 12 to 16 carbon atoms and having an average degree of polymerization of 1.6.

Other examples include alkyl polyglycoside surfactant compositions which are comprised of mixtures of compounds of formula I wherein Z represents a moiety derived from a reducing saccharide containing 5 or 6 carbon atoms; a is a number having a value from 1 to about 6; b is zero; and R_1 is an alkyl radical having from 8 to 20 carbon atoms. The compositions are characterized in that they have increased surfactant properties and an HLB in the range of about 10 to about 16 and a non-Flory distribution of glycosides, which is comprised of a mixture of an alkyl monoglycoside and a mixture of alkyl polyglycosides having varying degrees of polymerization of 2 and higher in progressively decreasing amounts, in which the amount by weight of polyglycoside having a degree of polymerization of 2, or mixtures thereof with the polyglycoside having a degree of polymerization of 3, predominate in relation to the amount of monoglycoside, said composition having an average degree of polymerization of about 1.8 to about 3. Such compositions, also known as peaked alkyl polyglycosides, can be prepared by separation of the monoglycoside from the original reaction mixture of alkyl monoglycoside and alkyl polyglycosides after removal of the alcohol. This separation may be carried out by molecular distillation and normally results in the removal of about 70-95% by weight of the alkyl monoglycosides. After removal of the alkyl monoglycosides, the relative distribution of the various components, mono- and poly-glycosides, in the resulting product changes and the concentration in the product of the polyglycosides relative to the monoglycoside increases as well as the concentration of individual polyglycosides to

the total, i.e. DP2 and DP3 fractions in relation to the sum of all DP fractions. Such compositions are disclosed in U.S. patent 5,266,690, the entire contents of which are incorporated herein by reference.

Other alkyl polyglycosides which can be used in the compositions according to the invention are those in which the alkyl moiety contains from 6 to 18 carbon atoms in which the average carbon chain length of the composition is from about 9 to about 14 comprising a mixture of two or more of at least binary components of alkyl polyglycosides, wherein each binary component is present in the mixture in relation to its average carbon chain length in an amount effective to provide the surfactant composition with the average carbon chain length of about 9 to about 14 and wherein at least one, or both binary components, comprise a Flory distribution of polyglycosides derived from an acid-catalyzed reaction of an alcohol containing 6-20 carbon atoms and a suitable saccharide from which excess alcohol has been separated.

The preferred alkyl polyglycosides are those of formula I wherein R_1 is a monovalent organic radical having from about 10 to about 16 carbon atoms; b is zero; Z is a glucose residue having 5 or 6 carbon atoms; a is a number having a value from 1 to about 2, and most preferably is 1.4.

The surfactant mixture of the present invention is prepared by mixing an alkyl ether sulfate with an alkyl polyglycoside, respectively, in a ratio by weight of from about 1:1 to about 4:1, and preferably about 2:1.

THE FOAM STABILIZER

Foam stabilizers are typically employed in cleaning compositions in order to maintain the integrity of the foam in the presence of soil. Whereas the foam is formed by the surfactants contained in the cleaning composition, the foam stabilizer maintains the integrity of the foam once formed.

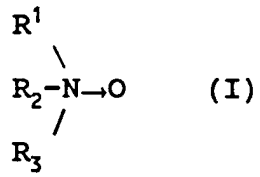
The foam stabilizers which may be employed in the present invention are those selected from the group

consisting of betaines, alkanolamides, amine oxides, and mixtures thereof.

Betaines, also known as zwitterionics, are derivatives of aliphatic quaternary ammonium, phosphonium and sulphonium compounds in which the aliphatic radical may be straight chained or branched, and wherein one of the aliphatic substituents contains from about 8 to about 18 carbon atoms and one contains an anionic water-solubilizing group such as carboxy, sulpho, sulphato, phosphato or phosphono. Those betaines encompassed by the present invention are generally alkyl betaines, alkyl amino betaines and alkyl amido betaines. Specific examples thereof include, but are not limited to, coco-betaine and cocamidopropyl betaine.

The fatty acid alkanolamides which may be used in the present invention contain from about 8 to about 18, and preferably from about 12 to about 14 carbon atoms in the alkyl group of the fatty acid residue. The amide group may be substituted either by two C_1-C_3 hydroxyalkyl groups, such as, for example, a dialkanolamide, or by one such hydroxyalkyl group and by one hydrogen or a C_1-C_3 alkyl group. Specific examples of alkanolamides which may be used include, but are not limited to, cocodiethanolamide and laurylmyristic monoethanolamide.

Amine oxides which may be used in accordance with the present invention are of general formula II:



(I)

wherein R^1 is an alkyl or alkenyl radical having from about 8 to about 18 carbon atoms, and R^2 and R^3 are individually alkyl or hydroxyalkyl radicals having from 1 to about 3 carbon atoms. Specific examples of amine oxides which may be employed include, but are not limited to, cocamine oxide and cocamidopropylamine oxide.

According to one embodiment of the present invention,

there is provided a process for making a surfactant composition having enhanced foam stability. The process involves combining from about 5% to about 40% by weight, and preferably from about 20% to about 40% by weight of the above-disclosed surfactant mixture with from about 1% to about 10% by weight, and preferably from about 2% to about 5% by weight of the above-disclosed foam stabilizer, the remainder, up to 100%, water. In a particularly preferred embodiment, the surfactant mixture consists of a C_{12}-C_{14} alkyl ether sulfate having 2 moles of ethylene oxide in admixture with an alkyl polyglycoside of formula I wherein R_1 is a monovalent organic radical having from about 12 to about 16 carbon atoms, b is zero and a is a number having a value of about 1.4.

The present invention is also directed to a novel cleaning composition possessing enhanced foam stability properties based on the above-disclosed surfactant mixture and foam stabilizer. According to this aspect of the invention, the cleaning composition contains from about 5 to about 40% by weight, and preferably from about 20 to about 40% by weight, of the above-disclosed surfactant mixture in combination with from about 1 to about 10% by weight, and preferably from about 2 to about 5% by weight of the above-disclosed foam stabilizer. The cleaning composition may also contain auxilliaries such as solvents, antimicrobials, thickeners, corrosion inhibitors, preservatives, dyes and perfume oils.

The remainder of the cleaning composition, to a total of 100% by weight, comprises water.

The present invention will be better understood from the examples which follow, all of which are intended to be illustrative only and not meant to unduly limit the scope of the invention. Unless otherwise indicated, percentages are on a weight-by-weight basis.

EXAMPLES

The cleaning compositions of Examples 1-6 were formulated on a 28% total actives basis, i.e., 12% active

C_{12}-C_{14} alkyl ether sulfate containing from 1 to 3 moles of ethylene oxide, 12% active GLUCOPON® 600, and 4% active foam stabilizer. Foam stability performance was evaluated using the Modified Shell Terg-o-tometer test which involved adding 0.5 gram pellets of a soil consisting of Crisco, potato, milk and olive oil, every 30 seconds, to 400 ml of each surfactant solution in diluted form, in a tergotometer. Foam was generated by agitation of each solution for two minutes at 125 rpm. The speed was then reduced to 50 rpm for the duration of the test, which ended at the point when there was no more foam. The results thereof, found in Table I, represent the number of 0.5 gram pellets of soil required to achieve a no foam endpoint. The more 0.5 gram pellets required, the better the foam stability of the cleaning composition.

Table I

Example	Foam Stabilizer	1 EO	2 EO	3 EO
1	coco-betaine	14.9	17.3	19.1
2	cocamidopropyl betaine	15.0	17.6	20.5
3	cocodiethanolamide	12.8	17.8	19.3
4	laurylmyristic monoethanolamide	11.5	17.4	19.5
5	cocamine oxide	16.9	17.0	19.0
6	cocamidopropylamine oxide	13.1	17.6	20.4

Comparative examples 7-12 comprised a combination of the above ether sulfate at 24% actives and the various foam stablizers at 4% actives, for a total actives concentration of 28%. The results of these foam stability tests are found in Table II.

Table II

Comp. Ex.	Foam Stabilizer	1 EO	2 EO	3 EO
7	coco-betaine	17.3	15.4	14.5
8	cocamidopropyl betaine	16.8	15.5	14.6
9	cocodiethanolamide	14.3	13.6	13.6
10	laurylmyristic monoethanolamide	13.9	14.0	13.9
11	cocamine oxide	18.5	15.9	15.0
12	cocamidopropylamine oxide	16.0	15.3	15.8

Comparative examples 13-18 comprised a combination of the GLUCOPON® 600 at a percent active of 24% and the various foam stabilizers at a percent actives of 4% for a total actives concentration of 28%. The results of these foam stability tests are found in Table III.

Table III

Comp. Ex.	Foam Stabilizer	Foam Stability
13	coco-betaine	17.5
14	cocamidopropyl betaine	19.8
15	cocodiethanolamide	17.6
16	laurylmyristic monoethanolamide	20.1
17	cocamine oxide	15.3
18	cocamidopropylamine oxide	18.9

What is claimed is:

1. A process for making an aqueous cleaning composition having enhanced foam stability comprising:

(a) providing a surfactant composition consisting essentially of:

(i) an alkyl ether sulfate having from 1 to about 4 moles of ethylene oxide; and

(ii) an alkyl polyglycoside of formula I:

$$R_1O(R_2O)_b(Z)_a \qquad I$$

wherein R_1 is a monovalent organic radical having from about 6 to about 30 carbon atoms; R_2 is divalent alkylene radical having from 2 to 4 carbon atoms; Z is a saccharide residue having 5 or 6 carbon atoms; b is a number having a value from 0 to about 12; a is a number having a value from 1 to about 6, wherein components (a)(i) and (a)(ii), respectively, are combined in a percent actives ratio ranging from 1:1 to about 4:1;

(b) providing a foam stabilizer selected from the group consisting of a betaine, an alkanolamide, an amine oxide, and mixtures thereof; and

(c) combining components (a) and (b).

2. The process of claim 1 wherein the alkyl ether sulfate contains 2 moles of ethylene oxide.

3. The process of claim 2 wherein the alkyl ether sulfate is a C_{12}-C_{14} alkyl ether sulfate.

4. The process of claim 1 wherein in formula I R_1 is a monovalent organic radical having from about 12 to about 16 carbon atoms, b is zero and a is a number having a value of about 1.4.

5. The process of claim 1 wherein the foam stabilizer is a betaine.

6. The process of claim 1 wherein the foam stabilizer is an alkanolamide.

7. The process of claim 1 wherein the foam stabilizer is an amine oxide.

8. The process of claim 1 wherein the cleaning composition contains from about 5% to about 40% by weight of the surfactant mixture and from about 1% to about 10% by weight of the foam stabilizer with remainder, up to 100%, water.

9. The process of claim 1 wherein components (a)(i) and (a)(ii), respectively, are combined in a percent actives ratio of about 2:1.

10. A process for making an aqueous cleaning composition having enhanced foam stability comprising:

(a) providing from about 20% to about 40% by weight of a surfactant composition consisting essentially of:

(i) a C_{12}-C_{14} ether sulfate having 2 moles of ethylene oxide; and

(ii) an alkyl polyglycoside of formula I:

$$R_1O(R_2O)_b(Z)_a \qquad I$$

wherein R_1 is a monovalent organic radical having from about 12 to about 16 carbon atoms; R_2 is a divalent alkylene radical having from 2 to 4 carbon atoms; Z is a saccharide residue having 5 or 6 carbon atoms; b is zero; a is a number having a value about 1.4, wherein components (a)(i) and (a)(ii), respectively, are combined in a percent actives ratio of about 2:1;

(b) providing from about 2% to about 5% by weight of a foam stabilizer selected from the group consisting of a betaine, an alkanolamide, an amine oxide, and mixtures thereof;

(c) providing the remainder, to 100%, water; and

(d) combining the surfactant mixture, foam stabilizer

and water to form the aqueous cleaning composition.

11. An aqueous cleaning composition having enhanced foam stability properties consisting essentially of:

(a) a surfactant mixture consisting essentially of:

(i) an alkyl ether sulfate having from 1 to about 4 moles of ethylene oxide; and

(ii) an alkyl polyglycoside of formula I:

$$R_1O(R_2O)_b(Z)_a \qquad I$$

wherein R_1 is a monovalent organic radical having from about 6 to about 30 carbon atoms; R_2 is a divalent alkylene radical having from 2 to 4 carbon atoms; Z is a saccharide residue having 5 or 6 carbon atoms; b is a number having a value from 0 to about 12; a is a number having a value from 1 to about 6, wherein components (a)(i) and (a)(ii), respectively, are combined in a percent actives ratio ranging from 1:1 to about 4:1;

(b) a foam stabilizer selected from the group consisting of a betaine, an alkanolamide, an amine oxide, and mixtures thereof; and

(c) water.

12. The composition of claim 11 wherein the alkyl ether sulfate contains 2 moles of ethylene oxide.

13. The composition of claim 12 wherein the alkyl ether sulfate is a C_{12}-C_{14} ether sulfate.

14. The composition of claim 11 wherein in formula I R_1 is a monovalent organic radical having from about 12 to about 16 carbon atoms, b is zero and a is a number having a value of about 1.4.

15. The composition of claim 11 wherein the foam stabilizer is a betaine.

16. The composition of claim 11 wherein the foam

stabilizer is an alkanolamide.

17. The composition of claim 11 wherein the foam stabilizer is an amine oxide.

18. The composition of claim 11 wherein the surfactant mixture is present in an amount of from about 5% to about 40% by weight, the foam stabilizer is present in an amount of from about 1% to about 10% by weight, and remainder, up to 100%, water.

19. The composition of claim 11 wherein components (a)(i) and (a)(ii), respectively, are combined in a percent actives ratio of about 2:1.

20. An aqueous cleaning composition having enhanced foam stability consisting essentially of:

(a) from about 5% to about 40% by weight of a surfactant mixture consisting essentially of:

(i) a C_{12}-C_{14} ether sulfate having 2 moles of ethylene oxide; and

(ii) an alkyl polyglycoside of formula I:

$$R_1O(R_2O)_b(Z)_a \qquad I$$

wherein R_1 is a monovalent organic radical having from about 12 to about 16 carbon atoms; R_2 is a divalent alkylene radical having from 2 to 4 carbon atoms; Z is a saccharide residue having 5 or 6 carbon atoms; b is zero; a is a number having a value of about 1.4, wherein components (a)(i) and (a)(ii), respectively, are combined in a percent actives ratio of about 2:1;

(b) from about 1% to about 10% by weight of a foam stabilizer selected from the group consisting of a betaine, an alkanolamide, an amine oxide, and mixtures thereof; and

(c) remainder, to 100%, water.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/00215

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :C11D 1/29, 1/90, 1/94, 3/48
US CL :510/131, 132, 138, 427, 470, 501, 506, 495
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)

U.S. : 510/131, 132, 138, 427, 470, 501, 506, 495

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

NONE

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

APS: glycoside# or sufate# or alkanolamide#

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P --- Y,P	US 5,646,100 A (HAUGK ET AL) 08 July 1997 (08-07-97), abstract, column 1 lines 23-44; EX. I-III and claims.	18 ------- 1,5,8,11- 15,18
Y	US 5,503,779 A (ADAMY ET AL) 02 April 1996 (02-04-96), abstract; column 3, lines 10-26; column 4, line 35-column 6, line 42; example I and claims.	1-20
Y	US 4,844,821 A (MERMELSTEIN ET AL) 04 July 1989 (04-07-89), column 9, line 14-column 12, line 2; and examples.	1-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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Date of the actual completion of the international search 25 FEBRUARY 1998	Date of mailing of the international search report 13 MAR 1998
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