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BIODEGRADABLE DETERGENT FOR AUTOMATIC CAR WASH SYSTEMS

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ABSTRACT OF THE DISCLOSURE

Biodegradable detergent for automatic car wash systems, and in particular "tunnel-type" car wash systems, consists essentially of: (a) from about 5 to 12 parts by weight of a nonionic surfactant, (b) from about 2 to 7 parts by weight of an anionic surfactant which is the phosphate ester of nonionic (a), (c) from about 2 to 10 parts by weight of linear alkylbenzene sulfonate anionic surfactant, (d) from about 0 to 10 parts by weight of detergent builder, (e) from about 0 to 2.0 parts by weight of alkali, and (f) from about 91 to 59 parts by weight of water, based on 100 parts by weight of detergent. This detergent is efficaciously deployed in very dilute concentrations in aqueous solutions of up to 1 part of detergent per 400 parts of water.

BACKGROUND OF THE INVENTION

(1) Field of the invention

The present invention pertains to detergent compositions, and in particular to biodegradable detergent compositions specifically adapted for use in "tunnel-type" automatic car wash systems.

(2) Prior art

The art of vehicle cleaning has experienced tremendous strides and growth with perhaps the most important innovation being that of automatic vehicle washing systems. These automated systems greatly facilitate the cleaning of the exterior of vehicle bodies while reducing the manpower requirements. Two such automatic systems which are commonly deployed are the "stall-type" coin-operated system and the "tunnel-type" system. It is the latter to which the present invention is particularly directed.

Tunnel-type vehicular or car wash systems generally comprise a conveyor section having disposed therealong suitable apparatus for performing specified stages of exterior vehicle washing and cleaning. For instance, at one stage there is provided scrubbing brushes which remove dirt from the entire exterior of the vehicle body; another stage washes the hubcaps of the wheels; another stage rinses the vehicle body; another stage air dries, through forced air compressors, the body of the vehicle. This type of conveyor arrangement with the different stages for cleaning the exterior of the vehicle are well known and is not intended to be a part of the invention.

The success of the automatic tunnel-type system is directly related to the detergent employed in the scrubbing stage of the system. Heretofore, it has been found that the detergents generally employed for this purpose have certain inherent drawbacks, among which are: (1) the tendency to leave water spots or "breaks" on the vehicle body because of deficient sheeting action on the vehicle body; (2) the automotive body is left with a soil residue after cleaning because the wash water is generally recaptured in the "reclaim pits" and recirculated and reused a multitude of times thereby promoting soil redeposition on the vehicle body; (3) the detergent cannot be employed in very dilute solutions thereby discounting the economic advantages of the automatic vehicle or car wash system.

The present invention seeks to overcome these and other drawbacks in detergents for automatic car wash systems while providing other advantages which are elucidated below.

SUMMARY OF THE INVENTION

The present invention provides for an improved liquid, biodegradable, detergent concentrate composition particularly adapted for tunnel-type automatic car wash systems which consists essentially of a mixture of:

(a) a nonionic surfactant,
(b) an anionic surfactant which is the phosphate ester of the nonionic surfactant (a),
(c) a linear alkylbenzene sulfonate anionic surfactant,
(d) a detergent builder,
(e) an alkali, and
(f) water.

This biodegradable composition has been found to be effective in extremely dilute aqueous solutions of up to 1 part of detergent per 400 parts of water. Furthermore, this composition has been found to have the following attributes rendering it extremely efficacious in its desired application: (1) storage stability at temperatures of up to about 165° F.; (2) non-corrosive to vehicle body and body trim as well as being a non-etchant for the glass portions of the vehicle body; (3) inhibits soil redeposition; (4) obviates the problem of water spots; and (5) lubricates the conventional plastic bristles of the scrubbing brushes.

For a more comprehensive discussion of the present invention reference is made to the following detailed description and examples thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In accordance with the present invention there is provided a biodegradable, liquid, detergent composition or detergent concentrate composition consisting essentially of a mixture of (a) a nonionic surfactant, (b) a phosphate ester anionic surfactant, (c) a linear alkylbenzene sulfonate anionic surfactant, (d) a detergent builder, (e) an alkali, and (f) water.

It is to be noted that this composition is closely related to that disclosed in the Wyandotte Chemicals Corporation publication entitled, "Plurafac Nonionic Surfactants For Use in Biodegradable Formulations," 4th edition, 2nd printing, published in May 1969. This publication discloses on page 14 a car wash formulation specifically designed for use in coin-operated systems containing a nonionic surfactant, a phosphate ester anionic surfactant, a detergent builder and water, and which is effective in aqueous solutions at concentrations ranging from 1:35 to 1:50 and which is storage stable up to a temperature of about 120° F. However, the present compositions differ from those of the reference publication by the addition of the linear alkylbenzene sulfonate which enables the present composition to be used in tunnel-type systems. Moreover, it has unexpectedly been found that the addition of the linear alkylbenzene sulfonate provides (a) improved detergency, (b) increases the storage stability of the concentrate to a temperature of about 165° F., and (c) enables the detergent to be effectively employed in dilute concentrations of up to about 1:400 in typical aqueous use solutions.

The present compositions generally consist essentially of (a) from about 5 to 12 parts by weight of the nonionic surfactant, (b) from about 2 to 7 parts by weight of the phosphate ester anionic surfactant, (c) from about 2 to 10 parts by weight of linear alkylbenzene sulfonate anionic surfactant, (d) from about 0 to 10 parts by weight of detergent builder, (e) from about 0 to 2.0 parts by weight of alkali, and (f) from about 91 to 59 parts by weight of water, based on 100 parts by weight of the compositions.

Preferably, the present compositions consist essentially of (a) from about 9.0 to 11.0 parts of nonionic surfactant, (b) from about 3.0 to 6.0 parts of phosphate ester anionic surfactant, (c) from about 4.0 to 9.0 parts of linear alkylbenzene sulfonate, (d) from about 4.0 to 6.0 parts of detergent builder, (e) from about 0.5 to 1.0 part of alkali and from about 79.5 to 67.0 parts of water, based on 100 parts by weight of the composition.

The nonionic surfactant which may be used in the practice of the present invention is an alkylene oxide condensate of linear aliphatic alcohols, i.e. alkanols, having from 8 to 20 carbon atoms or mixtures thereof. These surfactants are prepared by conventional oxyalkylene condensation reactions well known in the art. Generally, they are prepared by reacting an alkylene oxide with the linear aliphatic alcohol in the presence of a suitable oxyalkylation catalyst, such as sodium hydroxide, potassium hydroxide, and the like at a temperature of about 125° C. and at the pressure of about 34 to 90 p.s.i.g.

Preferred alkylene oxides for the condensation reaction herein, are ethylene oxide, propylene oxide or mixtures thereof.

When both ethylene oxide and propylene oxide are utilized, they are generally used in a weight ratio of ethylene oxide to propylene oxide ranging from about 0.5:1 to 6:1.

The total alkylene oxide content of the nonionic surfactant generated by the condensation reaction ranges from about 40 to 85% of the total weight of the surfactant, and preferably from about 60 to 85% of the total weight of the surfactant.

The alcohols which are reacted with the alkylene oxides, as noted, generally have from 8 to 20 carbon atoms, and preferably from 10 to 18 carbon atoms. They are essentially linear primary aliphatic alcohols and wherein at least seventy weight percent of the alcohol reactant should comprise an alcohol or mixture of alcohols having from 12 to 16 carbon atoms. Examples of suitable alcohols include decyl alcohol, undecyl alcohol, dodecyl alcohol, tridecyl alcohol, tetradecyl alcohol, pentadecyl alcohol, cetyl alcohol, heptadecyl alcohol, stearyl alcohol, hydrogenated tallow alcohol, and mixtures thereof. The alcohols may be naturally derived, such as, from coconut oil, or they may be synthetically derived, such as, from linear alkanes or linear alkenes. Small amounts of branch-chained alcohols may be used in conjunction with the linear alcohols so long as there is no interference with the biodegradability of the resulting product. An example of the type of alcohol herein contemplated is commercially available from Shell Oil Company under the name Neodol 25 (a mixture of C_{12}–C_{15} alcohols). It is advantageous herein to employ a mixture of alcohols to prepare the surfactants because of the good balance of properties imparted to the resulting products.

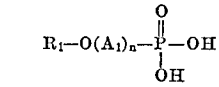
The preferred nonionic surfactant contemplated herein can be represented by the formula:

$$R—O(A)_n—H$$

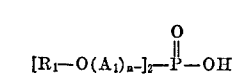
wherein R is an alcoholic residue or alkyl group having from 10 to 18 carbon atoms or mixtures thereof, A is either oxyethylene groups or a mixture of oxyethylene and oxypropylene groups in an ethylene oxide to propylene oxide weight ratio of from 0.5:1 to 6:1, and *n* is an integer sufficiently large to ensure that A constitutes from 40 to 85% of the total weight of the surfactant.

As is known in the art, when a mixture of compounds of the type used herein is employed there is generated a series of closely related homologs having varying oxyalkylene chain lengths. Thus, the values indicated above are average values. Typical of these nonionic surfactants are those disclosed and claimed in U.S. Pats. Nos. 3,340,309; 3,504,041; and Canadian Pat. No. 770,644.

The phosphate ester anionic surfactant which is contemplated herein is the phosphate ester of the above-defined nonionic surfactant. It is prepared by reacting the nonionic surfactant with polyphosphoric acid. Generally, the polyphosphoric acid is used in excess over stoichiometric requirements. The phosphate ester obtained by this reaction is, rather, a mixture of mono- and diesters corresponding to the formulae:



and



wherein R_1, A_1 and *n* have the meanings ascribed to R, A and *n*, above, and wherein the mixture comprises from 60 to 100% by weight of monoester and from 40 to 0% by weight of diester and A_1 constitutes from about 30 to 80% of the total weight of the ester. This anionic surfactant is an excellent solubilizing agent for the nonionic surfactant and thereby promotes the storage stability of the present composition.

Linear alkylbenzene sulfonate (LAS) anionic surfactants are widely known compounds in the detergent arts. They are generally prepared by the Friedel-Crafts reaction of an olefin and benzene or derivative thereof followed by the sulfonation of the intermediate 2-benzylalkylate. The olefin or alkene employed in the preparation of these compounds generally has from 10 to 18 carbon atoms and usually is an α-olefin. They are commonly available in alkali metal salt form, such as, the potassium or sodium salt of the linear alkylbenzene sulfonate. Suitable representative compounds of the type herein contemplated can be found in McCutcheon's "Detergents and Emulsifiers," 1970 edition.

The linear alkylbenzene sulfonate anionic surfactant of the present invention has been found to be critical

hereto since it not only enables the use of the present composition in tunnel-type systems, but, also, increases the storage stability of the composition up to a temperature of about 165° F. Moreover, by incorporating the linear alkylbenzene sulfonate into the composition it is possible to provide an excellent detergent in extremely dilute aqueous solutions of up to 1 part of detergent concentration per 400 parts of water. This result was unexpected since conventional compositions have much greater concentrations of detergent therein. For instance, the nonionic surfactant employed herein is usually efficacious only in solutions having concentrations of 1:50 and usually from about 1:35 to 1:50. Linear alkylbenzene sulfonates can only be diluted to a minimum concentration in solution of 1:200. Herein, the combination of the nonionic and linear alkylbenzene sulfonate can be diluted to a minimum of 1:400, thereby providing a very important economic benefit. In addition, the linear alkylbenzene sulfonate is a lubricant for the plastic bristles of the brushes usually deployed in the scrubbing stage of the tunnel-type automatic car wash system. A typical linear alkylbenzene sulfonate as contemplated herein is sold by Arco Chemical under the name Ultrawet which is a sodium salt of a linear alkylbenzene sulfonate.

The detergent builders are preferably sequestering agents which promote the solubility of the surfactants in water. These builders are well known and widely reported in the available patents and literature. Typical compounds are the alkali metal compounds, such as, alkali metal silicates, alkali metal carbonates, alkali metal phosphates, and the like. Representative of the alkali metal compounds which are sequestrants are sodium tripolyphosphate, tetrapotassium pyrophosphate, tetrasodium pyrophosphate, trisodium phosphate, sodium hexametaphosphate, and the like. Other useful compounds are sodium metasilicate, sodium metasilicate pentahydrate, soda ash, potassium carbonate, sodium bicarbonate, and the like. Also, alkali metal hydroxides, such as, sodium hydroxide, potassium hydroxide, lithium hydroxide, and the like, can be used. In fact any of the well known builders can be employed herein. However, it is preferred to employ the builders which function as sequestrants and, in particular, tetrapotassium pyrophosphate.

The alkali component of the concentrate is used to adjust the pH of the composition. Advantageously the pH should be in the range of 9.0 to 10.0. By the term "alkali" as used herein is meant either caustic soda (sodium hydroxide) or potassium hydroxide. Either of these materials, if deployed in the requisite amount, will impart the preferred pH to the system. The alkali can be eliminated from the composition for pH adjustment if it is used as the builder.

The present composition is prepared at room temperature and pressure by adding the ingredients together, with agitation, in the following sequence. Initially, the sequestrant is added to the water and mixed therewith until dissolved. Then, the solubilizing agent or phosphate ester anionic surfactant and the linear alkylbenzene sulfonate are added contemporaneously to the water and sequestrant solution. The pH of the mixture is then adjusted by adding the alkali, if needed. The last ingredient incorporated into the composition is the nonionic surfactant. After all the ingredients are in solution, the concentrate is ready for use.

To prepare a typical use solution the concentrate is added with agitation to an aqueous medium in a weight ratio of from 1:300 to 1:400 and preferably from 1:350 to 1:400.

It is to be understood that various other ingredients, such as, germicides, moldicides and the like, for example, sodium benzoate, can also be deployed herein in minor proportions. Also, freezing point depressants, such as, propylene glycol, isopropanol, and the like can be used in amounts up to about from 5 to 10% by weight of the composition without deleteriously affecting the properties of the compositions in respect to flash point, glass smearing and the like. Moreover, these freezing point depressants are also hydrotropes, and, therefore, their presence may be very worthwhile.

As noted above, the composition is biodegradable, noncorrosive, non-etching, a lubricant for the bristles of mechanical brushes, storage stable, efficient in very dilute solutions, and does not leave water spots on the vehicle body.

Following are specific examples of the present invention which are not intended to be construed as unduly limitative of the present invention. In the examples, all parts are by weight, absent indications to the contrary.

EXAMPLE I

A car wash composition adapted for tunnel-type car wash systems and in accordance with the present invention is prepared from the following:

Ingredient:	Amount, in parts
Nonionic surfactant A [1]	405.46
Phosphate ester W [2]	190.00
Linear alkylbenzene sulfonate M [3]	354.50
Tetrapotassium pyrophosphate	182.40
Caustic soda [4]	31.80
Water	2,652.40
Sodium benzoate [5]	15.20
	3,831.76

[1] A heteric nonionic condensate of a mixture of C_{12}–C_{15} alcohols and a mixture of ethylene oxide and propylene oxide, the ethylene oxide and propylene oxide being employed in a weight ratio of 1.5:1, the surfactant consisting of about 70% by weight of ethylene oxide and propylene oxide, and the alcohol mixture comprising about 20% C_{12} alcohol; 30% C_{13} alcohol; 30% C_{14} alcohol and 20% C_{15} alcohol.

[2] Prepared by reacting about 1.25 moles polyphosphoric acid per mole of a nonionic surfactant consisting of the condensation product of a mixture of C_{10}–C_{12} alcohols and a mixture of ethylene oxide and propylene oxide, the ethylene oxide and propylene oxide being employed in a weight ratio of about 5.7:1 and the resulting nonionic surfactant consisting of about 85% by weight of the ethylene oxide and propylene oxide mixture and wherein the alcohol generally comprises by weight about 70% decyl alcohol and 30% dodecyl alcohol.

[3] A sodium salt of a linear alkylbenzene sulfonate sold by Arco Chemical under the name Ultrawet 60K.

[4] Present at 63.6 parts of a 50% caustic soda solution.

[5] As a germicide.

The composition is prepared by mixing the tetrapotassium pyrophosphate into the water until dissolved. Then the linear alkylbenzene sulfonate and phosphate ester are added to the solution. The pH of the solution is then adjusted to 9.35 by the addition of the caustic soda. Lastly, the nonionic surfactant and the sodium benzoate are incorporated into the composition.

EXAMPLE II

Following the procedure of Example I, a detergent composition in accordance with the present invention is prepared from the following:

Ingredient:	Amount, in parts
Nonionic surfactant A	63
Phosphate ester W	55
Linear alkylbenzene sulfonate C	29
Tetrapotassium pyrophosphate	67
Caustic soda [1]	4.3
Water	786
	1,004.3

[1] Present as 8.6 parts of a 50% NaOH solution.

The product has a pH of about 9.3 and is storage stable at a temperature of about 140° F.

EXAMPLE III

A series of detergent compositions are prepared in accordance with the procedure outlined in Example I, from the following:

Ingredient	Amount, in parts			
	Detergent 3	Detergent 4	Detergent 5	Detergent 6
Nonionic surfactant A		10.5		
Nonionic surfactant B [1]	10.0			
Nonionic surfactant C [2]			9.0	
Nonionic surfactant D [3]				9.5
Phosphate ester W	4.0			3.5
Phosphate ester X [4]		3.5	4.0	
Linear alkylbenzene sulfonate M			4.5	4.5
Linear alkylbenzene sulfonate N [5]	5.0	5.0		
Tetrapotassium pyrophosphate	3.0	1.0	3.0	1.0
Caustic soda	0.7	0.8	0.8	0.8
Sodium benzoate	0.4	0.4	0.4	0.4
Freezing point depressant [6]		9.5		9.5
Water	76.9	69.3	78.3	70.8

[1] A condensation reaction product of a mixture of C_{12}–C_{15} alcohols with a 3:1 weight mixture of ethylene oxide and propylene oxide, the product constituting about 80% by weight of ethylene oxide and propylene oxide; the alcohol mixture comprising by weight of about 20% C_{12} alcohol; about 30% C_{13} alcohol; about 30% C_{14} alcohol and about 20% C_{15} alcohol.

[2] A condensation reaction product of propylene oxide with the condensation product of the mixture of C_{12}–C_{15} alcohols defined in footnote 1 and ethylene oxide, the ethylene oxide and propylene oxide being present in a weight ratio of about 4.5:1 and wherein the ethylene oxide and propylene oxide constitute about 60% by weight of the surfactant.

[3] A consensation reaction product of propylene oxide with the condensation product of the mixture of C_{12}–C_{15} alcohols defined in footnote 1 and ethylene oxide, the ethylene oxide and propylene oxide being present in a weight ratio of about 1.5:1 and wherein the ethylene oxide and propylene oxide constitute about 75% by weight of the surfactant.

[4] A reaction product about 1.25 moles of polyphosphoric acid per mole of a condensation product of a 0.5:1 weight mixture of ethylene oxide and propylene oxide and the mixture of C_{12}–C_{15} alcohols defined in footnote 1, the resulting condensation product containing about 75% by weight of ethylene oxide and propylene oxide.

[5] A sodium salt of a linear alkylbenzene sulfonate sold by Continental Oil Co. under the name Conoco C-650.

[6] A blend of isopropanol and propylene glycol in a weight ratio of isopropanol to propylene glycol of about 1.5:1.

Each of these compositions has a pH of about 9.3 and exhibits storage stability up to about 160° F.

What is claimed is:

1. In the cleaning of vehicular bodies in a tunnel-type wash system, the improvement which comprises washing the vehicular bodies with a solution comprised of (1) from about 300 to 400 parts of water and (2) 1 part of a composition consisting essentially of by weight:

(a) from about 9 to 11 parts of a nonionic surfactant corresponding to the formula:

$$R—O(A)_n—H$$

wherein R is the alcoholic residue of a linear aliphatic alcohol having from 10 to 18 carbon atoms and mixtures thereof, A is either oxyethylene groups or a mixture of oxyethylene and oxypropylene groups being present in a weight ratio of oxyethylene to oxypropylene groups ranging from about 0.5:1 to 6:1, and n is an integer sufficiently large such that A constitutes from about 60 to 85% of the weight of the surfactant;

(b) from about 3 to 6 parts of an anionic surfactant which is a mixture of mono- and diesters corresponding to the formulae:

$$R_1—O(A_1)_n—\overset{\overset{O}{\|}}{\underset{\underset{OH}{|}}{P}}—OH$$

and

$$[R_1—O(A_1)_n-]_2—\overset{\overset{O}{\|}}{P}—OH$$

wherein R_1 is the alcoholic residue of a linear aliphatic alcohol having from 10 to 18 carbon atoms and mixtures thereof, A_1 is either oxyethylene groups or a mixture of oxyethylene groups and oxypropylene groups in a weight ratio of oxyethylene to oxypropylene groups ranging from about 0.5:1 to 6:1, and n is an integer sufficiently large such that A_1 constitutes from about 30 to 80% by weight of the ester, and wherein the mixture of mono- and diester consists of from about 60 to 100% by weight of monoester and from about 40 to 0% by weight of diester;

(c) from about 4 to 9 parts of a linear alkylbenzene sulfonate anionic surfactant;

(d) from about 4 to 6 parts of water-soluble inorganic builder salts;

(e) from about 0.5 to 1.0 parts of an alkali which is either sodium hydroxide or potassium hydroxide; and

(f) from about 79.5 to 67.0 parts of water, based on 100 parts by weight of the composition.

2. The method of claim 1 wherein R is the residue of a mixture of linear aliphatic alcohols having from 12 to 15 carbon atoms.

3. The method of claim 1 wherein R_1 is the residue of a mixture of linear aliphatic alcohols having from 10 to 12 carbon atoms.

4. The method of claim 1 wherein R is the residue of a mixture of linear aliphatic alcohols having from 10 to 12 carbon atoms.

5. The method of claim 1 wherein R_1 is the residue of a mixture of linear aliphatic alcohols having from 12 to 15 carbon atoms.

6. The method of claim 1 wherein the water-soluble inorganic builder salt is an alkali metal phosphate sequestering agent.

7. The method of claim 1 wherein A and A_1 are each, respectively, the mixture of oxypropylene groups and oxyethylene groups.

8. The method of claim 1 wherein the composition has a pH ranging from about 9 to 10.

9. The method of claim 1 wherein the composition further includes sodium benzoate as a moldicide.

10. The method of claim 1 wherein the composition further includes propylene glycol or isopropanol as a freezing point depressant.

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