ABSTRACT OF THE DISCLOSURE

A slurry, light-duty liquid or heavy-duty liquid detergent composition containing a water-soluble alkylether sulfate as a hydro trope.

FIELD OF THE INVENTION

This invention relates to fluid detergent compositions of the alkylbenzene sulfonate type, and particularly to slurry compositions and liquid compositions.

DESCRIPTION OF THE PRIOR ART

In the manufacture of alkylbenzene sulfonate deter gents, it is conventional to form a so-called slurry of detergent and water, each being present in a major proportion. This slurry has a paste or cold cream consistency. The viscosity of the slurry is very high, thereby imposing line size limitations as well as large pumping requirements on the use of these slurries. The simple expedient of adding more water is unsatisfactory because the active component content is thereby decreased and more inert material must be transported. It is known that certain compounds will increase the solubility of the sulfonate in water and markedly decrease the viscosity of a given slurry; these compounds are called "hydrotropes" by the art.

Liquid detergents, both light duty and heavy duty, have problems with clarity because the washing effectiveness needs push the detergent content towards the saturation point at normal temperatures. Hydrotropes are used with these compositions to increase the solubility of the alkylbenzene sulfonate detergents and thereby lower the cloud point of the composition.

AN OBJECT OF THE INVENTION

An object of the invention is a slurry detergent composition which has a lower viscosity at a given alkyl benzene sulfonate and water content than conventional compositions; or has a higher alkylbenzene sulfonate content at a given viscosity than conventional compositions.

In particular, the object of the invention is an alkyl ben zene sulfonate liquid, light-duty detergent having a low cloud point.

FURTHER OBJECT

Another object is an alkylbenzene sulfonate liquid, heavy-duty detergent having a low cloud point.

Other objects of the invention will become apparent in the course of the detailed description thereof.

BRIEF SUMMARY OF THE INVENTION

In its broadest aspect, the invention encompasses a fluid detergent composition consisting essentially of (a) water-soluble alkylbenzene sulfonate having about 8-16 alkyl carbon atoms; (b) alkylether sulfate, having 4-10 alkyl carbon atoms, and about 15-55% of ethylene oxide units, in an amount at least sufficient to increase the water solubility of said sulfonate; and (c) liquid water, in a major proportion.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In one embodiment, the invention encompasses a slurry detergent composition consisting essentially of (a) water soluble alkylbenzene sulfonate having about 8-16 alkyl carbon atoms in an amount of about 30 to 50%; (b) alkylether sulfate, having 4-10 alkyl carbon atoms, and about 15-55% of ethylene oxide units, in an amount of about 2-10% based on said composition; and (c) the remainder liquid water in an amount sufficient to afford a pasty slurry composition.

In another embodiment, the invention encompasses a liquid, light-duty detergent composition including (a) alkyl benzene sulfonate having about 8-16 alkyl carbon atoms, about 18-32%; (b) alkylether sulfate, having 4-10 alkyl carbon atoms and about 15-55% of ethylene oxide units, in an amount of about 5-15%; and (c) at least one member of the class consisting of: (1) a foam stabilizer, (2) ethoxy nonionic detergent, and (3) alkyle ther sulfate detergent having at least about 12 alkyl carbon atoms, wherein said stabilizer, if present, is present in an amount of about 2-10% and said detergent, if present, is present in a total of about 10-25%; and (d) liquid water, as essentially the remainder.

In still another embodiment, the invention encompasses a liquid, heavy-duty detergent composition including (a) alkylbenzene sulfonate having about 8-16 alkyl carbon atoms about 13 to 25%; (b) a potassium polyhydrosulfate compound, about 10 to 30%; (c) alkylether sulfate, having 4-10 alkyl carbon atoms and about 15-55% of ethylene oxide units, in an amount of about 5-15%; and (d) similarly to the light-duty formulation above, a foam stabilizer, an ethoxyl nonionic detergent or an alkylether sulfate detergent. In general, the molecular weight of the alkylbenzene sulfonate constituent used in heavy-duty formulations may be slightly higher than that used in light-duty formulations.

It has been discovered that linear alkylbenzene sul fonate detergent compositions are surprisingly more responsive to the alkylether sulfate hydro trope than the highly branched alkylbenzene sulfonates, such as propylene tetramer-benzene sulfonate.

The invention is directed to fluid detergents composition which includes the very viscous paste or cold creamy types commonly called detergent slurry and low viscosity compositions commonly called liquid light-duty and liquid heavy-duty detergents—these are true solutions. In all of these fluid detergents, liquid water is present in a major proportion; in the light-duty liquid detergent compositions, the water normally forms more than 50% of the composition; whereas in the heavy-duty liquid compositions, the water content is less than but in the neighborhood of 50%. The amount of water present in slurry compositions is dependent on the viscosity desired and the hydro trope content, but is usually on the order of the sulfonate content. Always the water and the sulfonate detergent are the major components of the fluid detergents of the invention.

The detergent compositions of the invention may be classified as a water-soluble alkylbenzene sulfonate type. In these sulfonates the alkyl carbon atoms total about 8-16, commonly 12-14. These include the highly branched alkylbenzene sulfonates (ABS) and the linear alkylbenzene sulfonates (LABS)—the so-called biodegradable type. Illustrative of the ABS type are those derived from benzene and butylene trimer and propylene
Illustrative of the linear ABS type are those derived from benzene and monochloro-straight chain hydrocarbons, such as monochlorododecane. The linear alkylbenzene sulfonates are preferred.

The amount of defined sulfonate present will be dependent on the fluid composition wanted. In the case of light-duty liquid detergents, about 18–32% will generally be defined sulfonate. In the case of heavy-duty liquid detergents, about 13–25% will generally be defined sulfonate. (Herein all percentages are weight percent and are based on the total detergent composition.)

The detergent composition of the invention includes a water-soluble alkylxyethoxyl sulfate as a hydrotropic. This alkylxyethoxyl sulfate may be depicted: $R-(OC_2H_4)n-OH\rightarrow$ 

Where $R$ is an alkyl group having 4–10 carbon atoms with from 4–8 carbon atoms being preferred, $n$ is equal to at least 1 and $M$ may be any ion or radical conventionally known in the detergent art in connection with water-soluble detergent sulfates. $R$ may be branched or straight-chain, although a straight chain (n-alkyl) is preferred.

The alkylxyethoxyl sulfate includes at least about 1 ethylene oxide unit. When an alkanol and ethylene oxide are reacted, a spectrum of alkylxyethoxyl compounds is obtained, along with unreacted alkanol. It is customary to average the ethylene oxide units added over the "product mixture" and it is common to have "amounts" which are not integral to 10. In some cases, the alkylxyethoxyl sulfate used in the composition of the invention may have an ethylene oxide unit content of somewhat less than 1 unit per molecule.

For the purposes of this specification the ethylene oxide content of the hydrotropic here is defined according to another convention of the art, namely, weight percent of ethylene oxide units present based on the ether alcohol intermediate.

\[\frac{\text{Weight of ethylene oxide}}{\text{Weight of ether alcohol}} \times 100 = \text{EO\%}\]

The alkylxyethoxyl sulfate hydrotropic here contains between about 15 and 55% of ethylene oxide units.

The alkylxyethoxyl sulfate hydrotropic may include only one alkyl species or it may include more than one species as where the ether alcohol is prepared from a mixture of alkanols, for example, "ALFOL" 610 alcohols (trade name of Continental Oil Company) which contains n-alkanols of 6 carbon atoms 21% by weight, 8 carbon atoms 23% and 10 carbon atoms 24%. With such mixtures it is preferred that at least half of the species be of the 6 or 8 carbon atom variety.

Sufficient alkylxyethoxyl sulfate hydrotropic is present in the fluid detergent composition to increase the water solubility of the defined sulfonate detergent. Commonly, this is observed as a decrease in viscosity of a slurry detergent or lowering of the cloud point of a liquid detergent. The minimum amount is determined not only by the particular detergent present but also by the presence of other hydrotropes. In general, an economic limitation exists whereas no worthwhile improvement is obtained with the further addition of this hydrotropic.

In the case of slurry detergent compositions, the usage of the defined alkylxyethoxyl sulfate hydrotropic is between about 2 and 10% and more usually about 5–10%. In the case of liquid, light or heavy duty detergent compositions, the usage is between about 5 and 13% and more usually about 10–15%.

Commonly, the alkylxyethoxyl sulfates are available as aqueous solutions. It is to be understood the aforesaid usages are based on 100% active material.

Liquid, light-duty detergent compositions include, in addition to the alkylbenzene sulfonate detergent and hydrotropic, either a foam stabilizer or another detergent or both. Any of the foam stabilizers now used may be used with the defined hydrotropic. Among the materials which may be employed are: monoaïid oxides; diesters of the fatty alcohol series such as lauryl alcohol; fatty diethanolamides, such as coco-fatty diethanolamide; fatty alkylamides; free fatty acids and their esters with lower monohydric alcohols or glycols; saponins; higher aliphatic 1,2-diols, such as hexadecane-1,2-diol; imides of dicarboxylic acids, such as 4-octadecene-1,2-dicarboxylic acid imide; and esters of acyl phosphoric acid, such as the sodium salt of the methylester of p-tert-octylbenzene-phosphoric acid. The other detergent may be an ethoxy nonionic detergent or an alkylxyethoxyl sulfate detergent having at least about 12 alkyl carbon atoms. The thoxy nonionic detergent preferably has 10–18 alkyl carbon atoms and about 50–65% ethylene oxide unit content.

Operable materials include the condensation product of ethylene oxide with a fatty acid-containing material such as tall oil, alcohols, esters, aldehydes, amides, amines, a phenolic compound having lateral alkyl side chains, and the like.

Liquid heavy-duty detergent compositions include, in addition to the above-named ingredients of the light-duty formulations, a potassium polyphosphate compound. The complex or molecularly dehydrated polyphosphate salts are generally used in the form of the normal or completely neutralized salts, e.g., tetrapotassium pyrophosphate and pentapotassium tripolyphosphate. Partially neutralized salts, such as potassium acid tri-polyphosphate, may also be used. Mixtures of these materials may be used, but it is preferred that such mixtures include an effective amount of tetrapotassium pyrophosphate.

A particular embodiment of a slurry detergent composition, of the invention consists essentially of (a) alkylbenzene sulfonate having about 12 alkyl carbon atoms derived from propylene tetramer, about 40%; (b) sodium sulfate, about 5%; (c) hexylethoxyl sulfate having about 2 ethylene oxide units, about 5%; and (d) liquid water, about 50%. The sodium sulfate ingredient enhances detergency power but is not an essential ingredient of the formulation.

When a foam stabilizer is part of the light or heavy duty composition, it is present in an amount of about 2–10%. When the other defined detergent is part of the light or heavy duty composition, it is present in an amount of about 10–25%; should more than one of the other defined detergents be present, the total content is about 10–25%.

Various other ingredients may be added to the detergent composition as desired, including compatible perfumes, coloring materials, corrosion or anti-foam inhibitors, e.g., silicates, germicides, bleaching agents, optical bleaches or fluorescent brighteners, and the like. It is desirable to add a minor amount, such as 14–5% by weight, of a soil anti-redeposition agent, e.g., cellulose ethers. Suitable examples are methyl-, ethyl-, and hydroxyethylcellulose, alkali metal carboxymethylcellulose. In some cases, a lower alcohol may be present.

An especially suitable liquid, light-duty detergent composition includes (a) linear alkylbenzene sulfonate having about 12 alkyl carbon atoms, about 25%; (b) laurie diethanolamide foam stabilizers, about 5%; (c) hexylethoxyl sulfate having about 2 ethylene oxide units, about 10%; and (d) liquid water essentially the remainder.

The anionic detergents and sulfates which are or may be present in the detergent compositions of the invention are used in the form of their water-soluble salts, such as the alkali metal, alkaline earth metal, ammonium, amine, and alkylammonium salts. While the sodium, potassium, ammonium, and alkylammonium (e.g., mono-, di-, and triethanolamine) salts are preferred ordinarily, other salts such as the lithium, calcium, and magnesium salts may be used if desired. For general use, it is preferred to use the sodium and potassium salts.
Here a slurry detergent in an "as produced" condition had an "unmanageable" high viscosity. The "as produced" slurry analyzed: propylene tetramer- benzene sulfonate (sodium), 46%; sodium sulfate, 5%; unreacted alkylbenzene, about 1%; and water, 48%.

A typical commercial formulation was prepared by adding 5 parts of xylene sulfonate hydrotripe to 100 parts by weight of the as produced slurry. The xylene sulfonate was in the form of an aqueous solution containing about 40% of the active material.

A comparative formulation was prepared by adding 12 parts of liquid water to 100 parts of the as produced slurry.

Another formulation was prepared by adding 10 parts of 50% aqueous solution of a hydrotripe of the invention and 2 parts of liquid water. The hydrotripe was made from "ALFOL" 6 alcohol containing essentially only 6 carbon atoms to which was added 2 ethylene oxide units (46.5% ethylene oxide) and then converted to sodium hexylethylene sulfate (46.5% EtO). The viscosity of formulations Ia, Ib, and Ic was determined. The formulations and viscosities are presented in Table I.

### Table I

<table>
<thead>
<tr>
<th>Test</th>
<th>Linear Alkylbenzene Sulfonate</th>
<th>Alkylethoxy Sulfate</th>
<th>Viscosity (cst)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ia</td>
<td>Sodium octylbenzene sulfonate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ic</td>
<td>Sodium tetramethylenesulfonate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tests similar to the above are made on various slurries containing 46% by weight of various linear alkylbenzene sulfonate detergents and remainder water. To 100 parts by weight of this slurry are added 10 parts of 50% aqueous solutions of various alkylbenzene sulfonate hydrotripes and 2 parts water. The results of viscosity measurements on these slurries are presented in Table II.

### Table II

<table>
<thead>
<tr>
<th>Test</th>
<th>Linear Alkylbenzene Sulfonate</th>
<th>Alkylethoxy Sulfate</th>
<th>Viscosity (cst)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ia</td>
<td>Sodium octylbenzene sulfonate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ic</td>
<td>Sodium tetramethylenesulfonate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These results show that the various alkylethoxy sulfates tested all acted as effective hydrotripes for the various slurries.

### Table III

<table>
<thead>
<tr>
<th>Test</th>
<th>Hydrotripe</th>
<th>Cloud Point, ° F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ia</td>
<td>Sodium octylbenzene sulfonate</td>
<td></td>
</tr>
<tr>
<td>Ic</td>
<td>Sodium tetramethylenesulfonate</td>
<td></td>
</tr>
</tbody>
</table>

Liquid light duty detergents were formulated which differed only in the detergent present. Each formulation included 25% of detergent; 2% of laurel diethanolamide foam stabilizer; and the remainder water.

For comparative purposes, each of the above formulations was made into a corresponding composition by adding 10% of active hydrotripe. These included the conventional hydrotripes: ethanol, urea and sodium xylene sulfonate. In another, sodium hexyl sulfate was added—this was made by sulfating "ALFOL" 6 alcohol. In another, sodium hexylethylene sulfate (46.5% EtO) was added. The Cloud Point (° F.) was determined for each composition. Formulations Ia containing propylene tetramethylenesulfonate (sodium). Formulation Ib contained linear dodecylbenzene sulfonate (sodium). Formulation Ic contained sodium n-alkan sulfonate made by sulfating "ALFOL" 1218 alcohol which is a mixture of n-alkanols having 12, 14, 16, and 18 carbon atoms. The results are set out in Table III.

<table>
<thead>
<tr>
<th>Test</th>
<th>Hydrotripe</th>
<th>Cloud Point, ° F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ia</td>
<td>Sodium octylbenzene sulfonate</td>
<td></td>
</tr>
<tr>
<td>Ic</td>
<td>Sodium tetramethylenesulfonate</td>
<td></td>
</tr>
</tbody>
</table>

The results in Table III show the astounding fact that the alkylethylene sulfate is detrimental to the alkyl sulfate detergent cloud point. All the other materials showed substantial lowering of the cloud point.

In composition IIIa, the hexylethylene sulfate was less effective than either ethanol, urea, or xylene sulfonate—still it is an excellent hydrotripe.

Surprisingly, in composition IIIb, the hexylethylene sulfate was the most effective hydrotripe. Ethanol and urea were substantially less effective; xylene sulfonate was essentially the same; hexyl sulfate was significantly better than urea and ethanol and equal to xylene sulfonate. The difference between IIIa and IIIb is even more striking when the 28° F. higher cloud point of the no-hydrotripe formulation is taken into account.

### Table IV

<table>
<thead>
<tr>
<th>Test</th>
<th>Linear Alkylbenzene Sulfonate</th>
<th>Other Additive</th>
<th>Alkylethoxy Sulfate</th>
<th>Cloud Point, ° F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ia</td>
<td>Sodium octylbenzene sulfonate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ic</td>
<td>Sodium tetramethylenesulfonate</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tests similar to the above are made on other linear alkylbenzene sulfonate detergent-containing light duty liquids. Each formulation contains 25% by weight detergent, 5% foam stabilizer or 10% other detergent, and remainder water. To 100 parts by weight of each formulation are added 10 parts of active alkylbenzene sulfonate hydrotripe. The results of cloud point determinations are set out in Table IV.
All alkylethoxy sulfates tested are effective hydrotropes for the light duty liquid formulations tested.

Additional tests are made similar to the above on heavy duty liquid formulations containing 10% by weight detergent, 20% tetrapotassium pyrophosphate and remainder water. To 100 parts by weight of each formulation are added 7½ parts of active alkylethoxy sulfate hydrotrope. The results of cloud point determinations are set out in Table V.

<table>
<thead>
<tr>
<th>Example</th>
<th>Linear Alkylenezene</th>
<th>Alkylethoxy Sulfate</th>
<th>Cloud Point (° F.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Va........</td>
<td>Dodecylbenzene sulfonate.</td>
<td>None</td>
<td>205</td>
</tr>
<tr>
<td>Vb........</td>
<td>do</td>
<td>Sodium butylsulfate</td>
<td>40</td>
</tr>
<tr>
<td>Vc........</td>
<td>do</td>
<td>Sodium hexylsulfate</td>
<td>40</td>
</tr>
<tr>
<td>Vd........</td>
<td>do</td>
<td>Sodium octylsulfate</td>
<td>63</td>
</tr>
</tbody>
</table>

All alkylethoxy sulfates tested are effective hydrotropes for heavy duty liquid formulations.

Thus having described the invention, what is claimed is:

1. A slurry detergent composition consisting of:
   (a) water soluble alkylene sulfonate having about 8–16 alkyl carbon atoms in an amount of about 30 to 50% by weight;
   (b) alkylethoxy sulfate, having 4–8 alkyl carbon atoms and about 15–55% by weight of ethylene oxide units, in an amount of about 2–10% by weight based on said composition; and
   (c) the remainder liquid water in an amount sufficient to afford a pasty slurry composition.

2. The composition of claim 1 wherein said sulfonate is a linear alkylene sulfonate.

3. A slurry detergent composition consisting of:
   (a) alkylene sulfonate having about 12 alkyl carbon atoms derived from propylene tetramer, about 40% by weight;
   (b) sodium sulfate, about 5% by weight;
   (c) hexylethoxy sulfate having about 2 ethylene oxide units, about 5% by weight; and
   (d) liquid water, about 50% by weight.

4. A liquid, light-duty detergent composition consisting of:
   (a) alkylene sulfonate having about 8–16 alkyl carbon atoms, about 18–32% by weight;
   (b) alkylethoxy sulfate, having 4–8 alkyl carbon atoms and about 15–55% by weight of ethylene oxide units, in an amount of about 5–15% by weight; and
   (c) at least one member of the class consisting of:
      (1) ethoxy nonionic detergent, and
      (2) alkylethoxy sulfate detergent having at least about 12 alkyl carbon atoms, wherein said detergent is present in a total of about 10–25% by weight; and
   (d) liquid water, the remainder.

5. The liquid detergent composition of claim 4 wherein said sulfonate is linear alkylene sulfonate.

6. The liquid detergent composition of claim 4 wherein said nonionic detergent is alkanol ethoxy ether having 10–18 alkanol carbon atoms and about 50–65% by weight ethylene oxide units.

7. A liquid, light-duty detergent composition consisting of:
   (a) linear alkylene sulfonate having about 12 alkyl carbon atoms, about 25% by weight;
   (b) laurie diethanolamide foam stabilizer, about 5% by weight;
   (c) hexylethoxy sulfate having about 2 ethylene oxide units, about 10% by weight; and
   (d) liquid water, the remainder.

8. A liquid, heavy-duty detergent composition consisting of:
   (a) alkylene sulfonate having about 8–16 alkyl carbon atoms, about 13–25% by weight;
   (b) alkylethoxy sulfate, having 4–8 alkyl carbon atoms and about 15–55% by weight of ethylene oxide units, in an amount of about 5–15% by weight;
   (c) a potassium polyphosphate compound, in an amount of about 10–30% by weight;
   (d) at least one member of the class consisting of:
      (1) ethoxy nonionic detergent, and
      (2) alkylethoxy sulfate detergent having at least about 12 alkyl carbon atoms, wherein said detergent is present in a total of about 10–25% by weight; and
   (e) liquid water, the remainder.

9. The liquid detergent composition of claim 7 wherein said sulfonate is linear alkylene sulfonate.

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OTHER REFERENCES
LEON D. ROSDOL, Primary Examiner
M. HALPERN, Assistant Examiner
U.S. Cl. X.R.
252—152, 161, 752—138
CERTIFICATE OF CORRECTION

Patent No. 3501409 Dated March 17, 1970

Inventor(s) Ted P. Matson, Henry T. Watanabe and Dean R. Weimer

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

The name of Dean R. Weimer was omitted as a co-inventor in column 1, line 3.

SIGNED AND SEALED
AUG 4 - 1970

Edward M. Fletcher, Jr.
Attest: 

Attest: 

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents