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3,442,811

## HEAVY DUTY DETERGENT COMPOSITIONS

George L. O'Connor and Donald J. Foster, South Charleston, W. Va., assignors to Union Carbide Corporation, a corporation of New York

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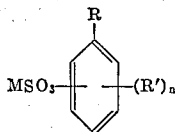
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12 Claims

### ABSTRACT OF THE DISCLOSURE

Where the ortho-meta-para distribution of a biodegradable alkali metal alkaryl sulfonate detergent is about 35-55: 1-20: 35-55 respectively improved foam stability is obtained. The detergent also contains a sequestering agent, corrosion inhibitor and a soil redeposition inhibitor. The alkyl aryl sulfonate is characterized by the formula:



where M is an alkali metal; R is a straight-chain secondary alkyl group of from about 5 to about 17 carbons;  $n$  is an integer having a value from 1 to 2;  $R'$  is an alkyl group of up to about 8 carbons but no more than the number of carbons in R; and the total number of carbon atoms in said alkyl group is in the range of from about 10 to 18.

This invention is concerned with a novel heavy-duty detergent composition containing, as the active ingredient, a biodegradable alkaryl sulfonate.

More particularly, this invention relates to a heavy-duty detergent formulation containing, as the active ingredient, a polyalkylbenzene sulfonate salt, said formulation being characterized by a high degree of detergency and foam stability.

Dry heavy-duty detergent compositions comprise basically (1) a major proportion of (a) an alkali metal alkylbenzene sulfonate and (b) a "builder" or sequestering agent in a weight ratio of (b) to (a) of at least 1:1, and (2) a minor proportion of (c) a corrosion inhibitor, (d) a soil redeposition inhibitor and (e) an inert diluent. Optionally, additives such as foam boosters, whiteners, brighteners and the like may be included, and the product, as commercially supplied, may contain up to about 10 weight percent, based upon total composition weight, of water. A typical formulation, as presently supplied, contains 100 parts by weight of an alkali metal alkylbenzene sulfonate, from about 100 to about 300 parts by weight of an alkali metal condensed phosphate as a builder, from about 30 to about 150 parts by weight of an inorganic salt as a diluent, from about 20 to about 50 parts by weight of a soluble alkali metal silicate as a corrosion inhibitor and from about 2 to about 5 parts by weight of an alkali metal carboxymethylcellulose as a soil redeposition inhibitor.

In the past the active ingredient was derived from an alkylbenzene having a highly branched alkyl chain, such as the product produced by the alkylation of benzene by a propylene tetramer. In addition, the alkylbenzene, as commercially supplied, was a mixture of compounds having alkyl groups containing from about 10 to about 15 carbon atoms, with the average chain length being in the range of from about 12 to about 13.

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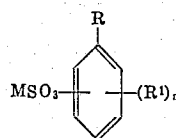
Because the sulfonates of these so-called "hard alkylbenzenes" are not readily degraded by bacterial action, considerable effort has been expended to provide a more biodegradable surface active material. One such material is an n-alkylbenzene sulfonate derived from a secondary n-alkylbenzene generally produced as a mixture of all of the secondary alkylbenzene isomers, as well as homologs containing from about 10 to about 15 carbons in the alkyl groups thereof and having average chain lengths of from about 12 to about 13 carbons. To date, however, no commercially-available product has been found which is comparable to the "hard" alkylbenzene sulfonate in both detergency and foam stability. For example, sulfonates derived from n-alkylbenzenes produced by the alkylation of benzene with an n-olefin or an n-alkyl chloride employing the conventional alkylation catalyst, aluminum chloride, have poorer foam stability than the "hard" alkylbenzene sulfonate. This, it has been discovered, is due to the high concentration of the 2-phenylalkane isomer in the alkylation product which is obtained from the aluminum chloride-catalyzed reaction. When the amount of the 2-phenylalkane isomer is reduced, as by distillation or by alkylation of benzene with an olefin and a hydrogen fluoride catalyst, the foam stability of the sulfonate of the resulting alkylbenzene is increased to at least the level of that of the hard alkylbenzene sulfonate. However, this improved foam stability is obtained at the sacrifice of detergent power. Thus, to obtain the same over-all detergent performance, it is necessary to employ a foam booster in combination with the soft alkylbenzene sulfonate derived from the aluminum chloride-catalyzed alkylation, an alternative which is undesirable because of the expense of the foam boosters.

As employed herein, the term "hard alkylaryl sulfonate" refers to an alkylaryl sulfonate derived from an alkylbenzene produced by the alkylation of benzene with a propylene tetramer; the term "HF soft alkylaryl sulfonate" refers to an alkylaryl sulfonate derived from an alkylbenzene produced by the hydrogen fluoride-catalyzed reaction of a straight-chain olefin with benzene, or an equivalent alkylbenzene having a low 2-phenylalkane content; and the term "AlCl<sub>3</sub> soft alkylbenzene sulfonate" refers to an alkylbenzene sulfonate derived from an alkylbenzene produced by the aluminum chloride-catalyzed reaction of a straight-chain secondary alkyl chloride with benzene, or an equivalent alkylbenzene having a relatively high 2-phenylalkane content.

It is an object of this invention to provide an alkylaryl sulfonate which, when incorporated in the above-described heavy-duty detergent formulation, combines biodegradability, a high level of detergency and good foam stability.

This and other objects of this invention are obtained by employing as the active detergent component at least one alkali metal polyalkylbenzene sulfonate of the formula:

(I)



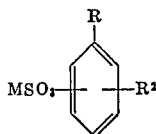
wherein M is an alkali metal, such as lithium, sodium or potassium, and preferably sodium; R is a straight-chain secondary alkyl group of from about 5 to about 17 carbons;  $n$  is an integer having a value of from 1 to 2;  $R'$  is an alkyl group of up to about 8 carbons and containing no more carbons than R; and the total number of carbons

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in R and R<sup>1</sup> is in the range of from about 10 to about 18, preferably from 12 to 15.

Preferred as the active ingredient are dialkylbenzene sulfonates of the formula:

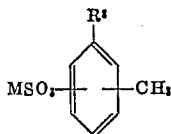
(II)



wherein M and R are as defined above and R<sup>2</sup> is an alkyl radical selected from the group consisting of methyl, ethyl and secondary n-alkyl of from 3 to 8 carbons, with the proviso that R<sup>2</sup> contains no more carbons than R, and the total number of carbons in R and R<sup>2</sup> is in the range of 10 to 18, preferably 12 to 15.

Especially preferred are the alkali metal secondary n-alkyltoluene sulfonates of the formula:

(III)



wherein R<sup>3</sup> is a straight-chain secondary alkyl group of from 9 to 17 carbons, preferably from 11 to 14 carbons; and M is an alkali metal. Particularly preferred as the active ingredient is the sodium sulfonate of a mixture of n-secondary-alkyltoluenes containing at least three next adjacent homologs, for example a mixture of a C<sub>12</sub>-alkyltoluene, a C<sub>13</sub>-alkyltoluene and a C<sub>14</sub>-alkyltoluene, and, for each homolog, all the possible secondary tolylalkane isomers as well as all possible o-, m- and p-alkyltoluene isomers, because of the superior detergency and foam stability provided by these mixtures. Still more preferred mixtures are those containing sulfonates derived from mixtures of C<sub>10</sub>-C<sub>15</sub>-alkyltoluenes having an average alkyl chain length of from about 10.5 to about 13.5, and especially 12 to about 13, carbon atoms.

These alkylaryl sulfonates are produced by the known steps of alkylation, sulfonation and neutralization.

Alkylation is effected by contacting toluene or other alkyl benzene with a source of secondary straight-chain radicals, for example an n-alkylchloride or an n-alkene, in the presence of an alkylation catalyst. These techniques are well known, and will not be extensively discussed. It has been found, however, that the isomer distribution of the alkyltoluene can be varied to a certain degree by the particular technique employed. This isomer distribution, which is retained during the sulfonation and neutralization steps, can significantly affect the properties of the resulting sulfonate salt as a surface active agent. For example, as is indicated above, a catalyst such as aluminum chloride provides an alkyltoluene which has a higher than random proportion of the 2-(tolyl)alkane. Unlike the situation obtained with the linear alkylbenzene sulfonates, however, the alkyltoluene sulfonate derived from a hydrogen fluoride-catalyzed alkylation is no better than, and is generally inferior to, the alkyltoluene sulfonate derived from an aluminum chloride-catalyzed alkylation. Thus, alkyltoluene sulfonates derived from alkyltoluenes produced by the aluminum chloride-catalyzed alkylation of toluene with alkyl chlorides are preferred.

The ortho-meta-para isomer distribution also may be effected by catalyst. For example, when aluminum chloride is the catalyst, the o-m-p ratio is about 10:60:30, but when an aluminum chloride complex with compounds such as ethers, alcohols, nitromethane and the like, is employed as the catalyst, the o-m-p ratio is generally about 35-55:1-20:35-55, although the distribution of the tolyl group along the alkyl group is essentially unchanged. Detergent compositions derived from the alkyltoluenes of reduced meta-isomer content are generally superior in their foam stability.

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The alkylation agent employed also affects the isomer distribution of the alkyltoluene product. For example, a 1-chloroalkane results in a product having a high proportion of 1-tolylalkane and an  $\alpha$ -olefin yields a product having a high proportion of 2-tolylalkane.

Isomer distribution also can be modified by purification techniques, such as by distillation, for a 2-tolylalkane will generally have a higher boiling point than its secondary isomers. This is a relatively undesirable technique for modifying isomer distribution, however, because in commercial processes the product will comprise a mixture of homologs over at least a three-carbon atom range. Thus, if distillation is relied on to remove the 2-tolylalkane one will also remove a portion of the higher boiling homologs.

The polyalkylbenzenes are converted to their sulfonate salts by conventional techniques of sulfonation and neutralization. The sulfonation is readily effected with agents such as sulfuric acid, oleum, chlorosulfonic acid, sulfamic acid, sulfur trioxide and the like. The resulting sulfonic acid is then neutralized in any suitable manner, for example, with aqueous alkali metal hydroxide to provide the alkali metal sulfonate salt. It is generally preferred to subject the sulfonation product to a hydrolysis, as by heating with added water for about 15 to about 30 minutes at below 50° C., to decompose acid anhydrides prior to the neutralization.

The resulting aqueous alkyltoluene sulfonate is then blended, either with or without an intermediate drying step, with the various components of the composition of this invention according to the known techniques, and then dried.

The sequestering agents employed in the compositions of this invention are alkali metal salts, preferably sodium salts of condensed phosphates. Suitable condensed phosphates include the pyrophosphates, the tripolyphosphates and the metaphosphates, with the tripolyphosphates, especially sodium tripolyphosphate, being preferred.

The corrosion inhibitors employed in the composition of this invention are the alkali metal salts, preferably sodium salts, of silicates having an SiO<sub>2</sub>:M<sub>2</sub>O molar ratio (wherein M is an alkali metal) of from about 1:1 to about 3:1. A sodium silicate wherein the SiO<sub>2</sub>:Na<sub>2</sub>O ratio is about 1.6:1 to 2.4:1 is preferred.

Diluents which can be employed are neutral alkali metal salts of inorganic acids, particularly salts of sulfuric acid. Preferred as a diluent is sodium sulfate.

Preferred as a soil redeposition inhibitor is an alkali metal salt of carboxymethyl cellulose, with sodium carboxymethylcellulose being particularly preferred.

Other ingredients, although not essential to the compositions of this invention, which may be present include foam boosters such as lauryldimethyl amine oxide or lauryldiethanolamide, whiteners, and the like. In addition, small amounts of impurities, such as sodium chloride, may be present in the formulation.

The following examples are illustrative. In the examples the following tests were employed for evaluation of the detergent compositions.

(1) Detergency.—Four 4-inch by 4-inch standard soiled swatches were charged to a beaker containing 1000 milliliters of a solution of the test formulation containing 0.025 weight percent of the sulfonate salt in water of the selected hardness at 120° F. The swatches were washed on a Tergo-O-Tometer at 100 r.p.m. for 15 minutes, then rinsed by hand-squeezing each swatch four times in each of two beakers of 500 milliliters of distilled water at 120° F. and dried by ironing. Detergency was determined by the percent soil removed as calculated from the equation:

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$$\text{Percent SR} = \frac{R_x - R_y}{R_s - R_y} \times 100$$

wherein percent SR is percent soil removed, R<sub>x</sub> is the reflectance of the soiled test swatches after washing, R<sub>y</sub> is the reflectance of the soiled swatches before washing and

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$R_z$  is the reflectance of the unsoiled white test cloth. The reflectance was determined with a Photovolt Reflectometer equipped with a Tristimulus green filter.

(2) Foam Stability.—Nine-inch diameter dinner plates were evenly spread with 2.5 grams of a standard soil of equal parts by weight of vegetable shortening and flour and a trace of red stain, which had been aged for 20 minutes to one week and heated at 100–120° F. before application. After aging for one hour, the soiled plates were washed in a solution containing the test formulation in an amount sufficient to provide 0.05 weight percent of sulfonate in water of the desired hardness prepared by dissolving the formulation in one liter of water at 115° F. and, after transferring the solution to a dishpan, adding an additional three liters of water heated at 100–120° F. through a funnel from a height of 24 inches to provide a uniform foam over the surface of the water. Two soiled plates were placed in the dishpan at a time and were washed individually with a dishcloth. The washing procedure was continued, two plates at a time, until a thin layer of soap suds was visible over about one-half the area of the dishpan. The number of plates washed at this point is an indication of the foam stability of the detergent formulation, and is reported herein as the average of two runs.

#### Example 1

A number of heavy-duty dry formulations were prepared according to the following formulation.

Ingredient:	Parts by weight
Sodium alkylaryl sulfonate	100
Sodium sulfate	96.3
Sodium tripolyphosphate	133.2
Sodium metasilicate	33.3
Sodium chloride	3.7
Sodium carboxymethylcellulose	3.7

Each formulation was then evaluated for detergency and foam stability, the results of which are summarized in Table I below. In the table, the formulations are identified as follows:

A. Sodium secondary-n-dodecyltoluene sulfonate (average molecular weight of 362) prepared by the aluminum chloride-catalyzed alkylation of toluene with a mixture of random secondary-n-alkylchlorides of from 10 to 14 carbons and having an average of 12 carbons in the alkyl group, followed by sulfonation with sulfur trioxide and neutralization with sodium hydroxide.

B. Sodium secondary-n-tridecylbenzene sulfonate (average molecular weight of 362) prepared by the aluminum chloride-catalyzed alkylation of benzene with a mixture of random secondary-n-alkyl chlorides of from 11 to 15 carbons and having an average of 13 carbons in the alkyl group, followed by sulfonation with sulfur trioxide and neutralization with sodium hydroxide.

C. Sodium secondary-n-tridecylbenzene sulfonate (average molecular weight of 362) prepared by the hydrogen fluoride-catalyzed alkylation of benzene with a mixture of random n-internal olefins of from 11 to 15 carbons and having an average of 13 carbons in the alkyl group, followed by sulfonation with sulfur trioxide and neutralization with sodium hydroxide.

D. A commercially available "hard" sodium tridecylbenzene sulfonate having an average molecular weight of about 362.

TABLE I

Formulation	Detergency		Foam stability	
	50 p.p.m.	150 p.p.m.	50 p.p.m.	150 p.p.m.
A. ....	55.6	52.8	17.5	18
B. ....	58.0	53.0	14.5	15
C. ....	53.2	50.1	17.5	18.5
D. ....	54.9	54.0	15.0	18.0

As can be seen from Table I, of the three formulations containing a biodegradable alkylaryl sulfonate as the active ingredient, only the formulation of this invention (A)

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containing a dodecyltoluene sulfonate was generally equivalent to the formulation containing the "hard alkylbenzene sulfonate (D) in both detergency and foam stability. The remaining formulations were equivalent in only one of these properties. This result is more clearly seen in Table II, wherein the ratios of the performance of each biodegradable formulation to the performance of the "hard" formulation are set forth.

TABLE II

Formulation	Detergency		Foam stability	
	50 p.p.m.	150 p.p.m.	50 p.p.m.	150 p.p.m.
A. ....	1.01	0.98	1.17	1.0
B. ....	1.02	0.98	0.97	0.83
C. ....	0.97	0.93	1.17	1.03

#### EXAMPLE 2

Several formulations, each containing a biodegradable dialkylbenzene sulfonate in accordance with this invention, were produced according to the formula of Example 1, and then evaluated for foam stability. These formulations are identified as follows:

A. Sodium secondary-n-dodecylethylbenzene sulfonate having an average molecular weight of 376 derived from the aluminum chloride-catalyzed alkylation of ethylbenzene with a mixture of random secondary-n-alkyl chlorides having from 10 to 14 carbons and an average of 12 carbons.

B. Sodium secondary-n-dodecylxylene sulfonate having an average molecular weight of 376 derived from the aluminum chloride-catalyzed alkylation of xylene with a mixture of random secondary-n-alkylchlorides having from 10 to 14 carbons and an average of 12 carbons.

C. Sodium secondary-n-tridecyltoluene sulfonate having an average molecular weight of 376 derived from the hydrogen fluoride-catalyzed alkylation of toluene with a mixture of random internal n-olefins having from 11 to 15 carbons and an average of 13 carbons.

D. Sodium secondary-n-tridecyltoluene sulfonate having an average molecular weight of 376 derived from the aluminum chloride-catalyzed alkylation of toluene with a mixture of random secondary-n-alkyl chlorides having from 11 to 15 carbons and an average of 13 carbons.

E. Sodium secondary-n-tridecyltoluene sulfonate having an average molecular weight of 376 derived from aluminum chloride/nitromethane-catalyzed alkylation of toluene with a mixture of random secondary-n-alkyl chlorides having from 11 to 15 carbons and an average of 13 carbons.

TABLE III

Formulation	Foam stability	
	50 p.p.m.	150 p.p.m.
A. ....	16	18
B. ....	11.5	18
C. ....	14	15
D. ....	15	17
E. ....	16.5	18.5

#### EXAMPLE 3

In four experiments toluene was alkylated with either a random secondary-n-dodecyl chloride or a random secondary n-tridecyl chloride. For each molecular weight, one alkylation employed aluminum chloride as the catalyst and the other employed nitromethane-modified aluminum chloride as the catalyst. After sulfonation and neutralization, each of the resulting sodium dodecyltoluene sulfonates was incorporated into the heavy-duty detergent formulation set forth in Example 1. The evaluations of each formulation for foam stability are set forth in Table IV.

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TABLE IV

Active Ingredient	Catalyst	Foam stability	
		50 p.p.m.	150 p.p.m.
Dodecyltoluene sulfonate.....	AlCl <sub>3</sub>	13	14
Do.....	AlCl <sub>3</sub> , CH <sub>3</sub> NO <sub>2</sub>	16	18
Tridecyltoluene sulfonate.....	AlCl <sub>3</sub>	17	17.5
Do.....	AlCl <sub>3</sub> , CH <sub>3</sub> NO <sub>2</sub>	16	19

These data clearly establish that the reduction of the amount of m-alkyltoluene from about 50 to 60 percent to less than about 10 to 15 percent by the use of nitromethane-modified catalyst causes a significant improvement in foam stability of the resulting detergent formulation, particularly in hard water, as is evidenced by the results at 150 p.p.m.

## Example 4

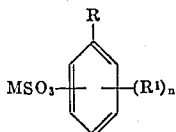
A mixture of di-secondary-n-heptylbenzene isomers was produced by alkylation of benzene with random secondary n-heptyl chlorides in the presence of aluminum chloride as a catalyst, sulfonated with sulfur trioxide and then neutralized with sodium hydroxide. The resulting sulfonate was then incorporated into the formulation set forth in Example 1, and the resulting formulation evaluated for foam stability. The number of plates washed at 50 and 150 p.p.m. hardness with this formulation was 15.5 and 19, respectively. This performance compares favorably with those of the tridecyltoluene sulfonate of Example 4. In addition, it is superior to foam stabilities of formulations containing tetradecylbenzene sulfonates produced by the aluminum chloride-catalyzed or the hydrogen fluoride-catalyzed alkylation of benzene as summarized in Table V.

TABLE V

Alkylbenzene	Catalyst	Foam stability	
		50 p.p.m.	150 p.p.m.
Tetradecylbenzene.....	AlCl <sub>3</sub>	8.5	9.5
Tetradecylbenzene.....	HF	13.5	17
Diheptylbenzene.....	AlCl <sub>3</sub>	15.5	19

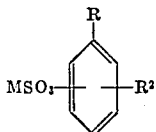
What is claimed is:

1. A biodegradable dry heavy-duty detergent composition consisting essentially of an alkali metal alkylaryl sulfonate, a sequestering agent, a corrosion inhibitor and a soil redeposition inhibitor, where said alkali metal alkylaryl sulfonate is at least one compound of the formula:



wherein M is an alkali metal; R is a straight-chain secondary alkyl group of from about 5 to about 17 carbons; n is an integer having a value of from 1 to 2; R<sup>1</sup> is an alkyl group of up to about 8 carbons but no more than the number of carbons in R; and the total number of carbons in said alkyl groups is in the range of from about 10 to about 18 wherein the o-m-p ratio of said compound is about 35-55:1-20:35-55.

2. A biodegradable dry heavy-duty detergent composition consisting essentially of an alkali metal alkylaryl sulfonate, a sequestering agent, a corrosion inhibitor and a soil redeposition inhibitor, where said alkali metal alkylaryl sulfonate is at least one compound of the formula:

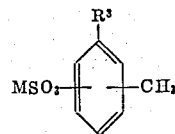


wherein M is an alkali metal; R is a straight-chain secondary alkyl group of from about 5 to about 17 carbons;

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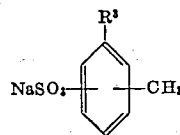
R<sup>2</sup> is an alkyl radical selected from the group consisting of methyl, ethyl and secondary-n-alkyl of from about 3 to about 8 carbons but no more carbons than R; and the total carbons in R and R<sup>2</sup> is in the range of from about 10 to about 18 wherein the o-m-p ratio of said compound is about 35-55:1-20:35-55.

3. A biodegradable dry heavy-duty detergent composition consisting essentially of an alkali metal alkylaryl sulfonate, a sequestering agent, a corrosion inhibitor and a soil redeposition inhibitor, where said alkali metal alkylaryl sulfonate is at least one alkali metal alkyltoluene sulfonate of the formula:



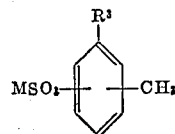
wherein R<sup>3</sup> is a secondary n-alkyl group of from 9 to 17 carbons and M is an alkali metal wherein the o-m-p ratio of said alkyltoluene is about 35-55:1-20:35-55.

4. A biodegradable dry heavy-duty detergent composition consisting essentially of an alkali metal alkylaryl sulfonate, a sequestering agent, a corrosion inhibitor and a soil redeposition inhibitor, where said alkali metal alkylaryl sulfonate is at least one sodium alkyltoluene sulfonate of the formula:



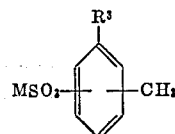
wherein R<sup>3</sup> is a secondary n-alkyl group of from 11 to 14 carbons wherein the o-m-p ratio of said alkyltoluene is about 35-55:1-20:35-55.

5. A biodegradable dry heavy-duty detergent composition consisting essentially of an alkali metal alkylaryl sulfonate, a sequestering agent, a corrosion inhibitor and a soil redeposition inhibitor, where said alkali metal alkylaryl sulfonate is a mixture of alkyltoluene sulfonates of the formula:



wherein R<sup>3</sup> is a secondary n-alkyl group of from 9 to 17 carbons and M is an alkali metal, said mixture having been produced by the sulfonation of a mixture of alkyltoluenes containing at least three next-adjacent homologs and, for each homolog, all possible secondary alkyltoluene isomers wherein the o-m-p ratio of said alkyltoluene is about 35-55:1-20:35-55.

6. A biodegradable dry heavy-duty detergent composition consisting essentially of an alkali metal alkylaryl sulfonate, a sequestering agent, a corrosion inhibitor and a soil redeposition inhibitor, where said alkali metal alkylaryl sulfonate is a mixture of alkyltoluene sulfonates of the formula:



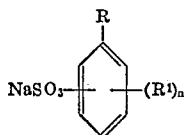
wherein R<sup>3</sup> is a secondary-n-alkyl group of 9 to 17 carbons and M is an alkali metal, said mixture having been produced by the sulfonation of a mixture of alkyltoluenes containing at least three next-adjacent homologs and, for each homolog, all possible secondary alkyltoluene isomers wherein the average alkyl chain length is in the range of

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from 10.5 to 13.5 carbons wherein the o-m-p ratio of said alkyltoluene is about 35-55:1-20:35-55.

7. A dry heavy-duty detergent composition consisting essentially of

- (1) 100 parts by weight of a sodium sulfonate of the formula:

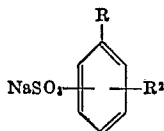


wherein R is a secondary n-alkyl group of 5 to 17 carbons, n is an integer having a value of from 1 to 2, R<sup>1</sup> is alkyl of up to 8 carbons and having no more carbons than R, and the total carbons in R and R<sup>1</sup> is in the range of 10 to 18 wherein the o-m-p ratio of said sodium sulfonate is about 35-55:1-20:35-55;

- (2) from about 100 to about 300 parts by weight of a sodium salt of a condensed phosphate;  
 (3) from about 30 to about 150 parts by weight of sodium sulfate;  
 (4) from about 20 to about 50 parts by weight of a sodium silicate having an SiO<sub>2</sub>:Na<sub>2</sub>O molar ratio of from about 1:1 to about 3:1, and  
 (5) from about 2 to about 5 parts by weight of sodium carboxymethylcellulose.

8. A biogradable dry heavy-duty detergent composition consisting essentially of

- (1) 100 parts by weight of a sodium sulfonate of the formula:

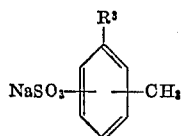


wherein R is secondary n-alkyl of 5 to 17 carbons, R<sup>2</sup> is a member selected from the group consisting of methyl, ethyl and secondary n-alkyl of 3 to 8 carbons, and the total carbons in R and R<sup>2</sup> is in the range of 10 to 18 wherein the o-m-p ratio of said sodium sulfonate is about 35-55:1-20:35-55;

- (2) from about 100 to about 300 parts by weight of a sodium salt of a condensed phosphate;  
 (3) from about 30 to about 150 parts by weight of sodium sulfate;  
 (4) from about 20 to about 50 parts by weight of a sodium silicate having an SiO<sub>2</sub>:Na<sub>2</sub>O molar ratio of from about 1:1 to about 3:1; and  
 (5) from about 2 to about 5 parts by weight of sodium carboxymethylcellulose.

9. A biogradable dry heavy-duty detergent composition consisting essentially of

- (1) 100 parts by weight of a sodium sulfonate of the formula:



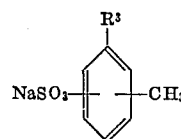
wherein R<sup>3</sup> is a secondary n-alkyl group of 9 to 17 carbons wherein the o-m-p ratio of said sodium sulfonate is from about 35-55:1-20:35-55;

- (2) from about 100 to about 300 parts by weight of a sodium salt of a condensed phosphate;  
 (3) from about 30 to about 150 parts by weight of sodium silicate having an SiO<sub>2</sub>:Na<sub>2</sub>O molar ratio of  
 (4) from about 20 to about 50 parts by weight of a sodium silicate having an SiO<sub>2</sub>:Na<sub>2</sub>O molar ratio of from about 1:1 to about 3:1; and  
 (5) from about 2 to about 5 parts by weight of sodium carboxymethylcellulose.

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10. A dry heavy-duty detergent composition consisting essentially of

- (1) 100 parts by weight of a sodium sulfonate of the formula:

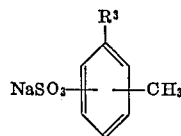


wherein R<sup>3</sup> is a secondary n-alkyl group of from 9 to 17 carbons wherein the o-m-p- ratio of said sodium sulfonate is about 35-55:1-20:35-55;

- (2) from about 100 to about 300 parts by weight of sodium tripolyphosphate;  
 (3) from about 30 to about 150 parts by weight of sodium sulfate;  
 (4) from about 20 to about 50 parts by weight of a sodium silicate having an SiO<sub>2</sub>:Na<sub>2</sub>O molar ratio of from about 1.6:1 to about 2.4:1 and  
 (5) from about 2 to about 5 parts by weight of sodium carboxymethylcellulose.

11. A biodegradable dry heavy-duty detergent composition consisting essentially of

- (1) 100 parts by weight of a mixture of sodium sulfonates of the formula:

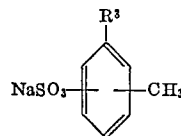


wherein R<sup>3</sup> is a secondary n-alkyl group of from 9 to 17 carbons, said mixture having been produced by the sulfonation of a mixture of alkyl toluenes containing at least three next-adjacent homologs and, for each homolog, all possible secondary alkyl toluene isomers wherein the o-m-p ratio of said alkyltoluene is about 35-55:1-20:35-55;

- (2) from about 100 to about 300 parts by weight of a sodium salt of a condensed phosphate;  
 (3) from about 30 to about 150 parts by weight of sodium sulfate;  
 (4) from about 20 to about 50 parts by weight of a sodium silicate having an SiO<sub>2</sub>:Na<sub>2</sub>O molar ratio of from about 1:1 to about 3:1; and  
 (5) from about 2 to about 5 parts by weight of sodium carboxymethylcellulose.

12. A biodegradable dry heavy-duty detergent composition consisting essentially of

- (1) 100 parts by weight of a mixture of sodium sulfonates of the formula:



wherein R<sup>3</sup> is a secondary n-alkyl group of from 9 to 17 carbons, said mixture having been produced by the sulfonation of a mixture of alkyltoluenes containing at least three next-adjacent homologs and, for each homolog, all possible secondary alkyltoluene isomers wherein the average alkyl chain length is in the range of 10.5 to 13.5 carbons wherein the o-m-p ratio of said alkyltoluene is about 35-55:1-20:35-55;

- (2) from about 100 to about 300 parts by weight of a sodium salt of a condensed phosphate;  
 (3) from about 30 to about 150 parts by weight of sodium sulfate;  
 (4) from about 20 to about 50 parts by weight of a sodium silicate having an SiO<sub>2</sub>:Na<sub>2</sub>O molar ratio of from about 1:1 to about 3:1; and

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(5) from about 2 to about 5 parts by weight of sodium carboxymethylcellulose.

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LEON D. ROSDOL, *Primary Examiner*.  
P. E. WILLIS, *Assistant Examiner*.

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