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ALKYL BENZENE SULFONATES HAVING HIGH SUSCEPTIBILITY TO BACTERIOLOGICAL DEGRADATION

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This invention relates to alkyl benzene sulfonate detergents which have a high susceptibility to bacteriological degradation and, more particularly, it relates to alkyl benzene sulfonate detergents having an alkyl group derived from dimers of straight-chain alpha-olefins.

In recent years, particularly since the second World War, there has been a remarkable growth in the synthetic detergent industry. The alkyl benzene sulfonates are one of the most important and most widely used of the synthetic detergents. They have been prepared from a variety of initial compounds by means of various processes.

In general, the alkyl portion of the molecule has been prepared by polymerizing an olefin such as propylene or butylene to the desired molecular weight range using a catalyst such as H_3PO_4, H_2SO_4, BF_3 or similar acid-type catalyst. Other methods of preparation involve the production of alcohols of the desired molecular weight by reacting an olefin with carbon monoxide and hydrogen in the so-called "Oxo" process, or by the oxidation of paraffinic hydrocarbons. Additional methods involve the production of a chlorinated hydrocarbon of the desired molecular weight range conveniently obtained by chlorinating the proper petroleum fraction such as a kerosene fraction.

In the next step, the olefin, alchol or chlorinated hydrocarbon is utilized to alkylate a mononuclear hydrocarbon such as benzene, toluene, any one or a mixture of the xylene isomers, ethyl benzene, n-propyl benzene or similar lower alkylated benzenes. Generally, benzene has been employed and is preferred.

The resulting alkylated benzene hydrocarbon is sulfonated with concentrated or fuming sulfuric acid or sulfur trioxide, and the sulfonic acid obtained is neutralized with a basic reagent to give the corresponding sulfonate, most commonly the sodum sulfonate.

Although the alkyl benzene sulfonates prepared from these various compounds had excellent detergent properties, they were rather resistant to degradation by bacteria. Consequently, when water containing these detergents reached waste treating facilities, they were sometimes incompletely consumed during the time the water was being treated. When this occurred in large-scale commercial waste disposal plants, small but detectable residual quantities of these alkyl benzene sulfonates were discharged in the effluent from the plant.

It now has been found possible to prepare alkyl benzene sulfonates which have a high susceptibility to bacteriological degradation, i.e., they are more quickly and more nearly completely consumed by bacteria, as compared with commercial alkyl benzene sulfonates prepared heretofore. These alkyl benzene sulfonates having a high susceptibility to bacteriological degradation are characterized by having an alkyl group attached to the benzene ring which group is derived by dimerizing straight-chain alpha-olefins with an organo-aluminum catalyst.

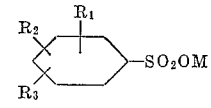
It is an object of this invention to provide alkyl benzene sulfonates having a high susceptibility to bacteriological degradation.

It is another object of this invention to provide alkyl benzene sulfonates having a high susceptibility to bacteriological degradation wherein an alkyl group is derived from dimers of straight-chain alpha-olefins.

It is another object of this invention to provide alkyl benzene sulfonates having a high susceptibility to bacteriological degradation wherein an alkyl group attached to the benzene ring is derived by dimerizing straight-chain alpha-olefins with an organo-aluminum catalyst.

Other objects not mentioned specifically will be apparent from the detailed description and claims that follow.

In accordance with this invention, alkyl benzene sulfonates having a high susceptibility to bacteriological degradation are prepared having the formula



wherein M is an alkali metal or ammonium, R_1 is hydrogen or an alkyl radical having from 1 to 3 carbon atoms, R_2 is hydrogen or an alkyl radical having from 1 to 3 carbon atoms, and R_3 is an alkyl radical having from 10 to 20 carbon atoms derived by dimerizing straight-chain alpha-olefins having the structural formula

$$R'—CH=CH_2$$

wherein R′ is an alkyl radical having from 3 to 8 carbon atoms. The alpha-olefin is dimerized with an organo-aluminum catalyst having the formula $Li_mAlR''_nH_{m+3-n}$, wherein Li is lithium, Al is aluminum, R″ is a hydrocarbyl group, H is hydrogen, and *m* may have a value of 1 or zero. When *m* is 1, *n* is zero; and when *m* is zero, *n* may be 1, 2, or 3, i.e., it has an integral value in the range from 1 to 3.

The alpha-olefins useful in the preparation of the dimers of this invention include the straight-chain olefins containing from 5 to 10 carbon atoms in the molecule, i.e., pentene-1, hexene-1, heptene-1, octene-1, nonene-1, and decene-1. The pure compounds may be employed or mixtures of these olefins, including mixtures produced by the controlled cracking of petroleum paraffin waxes, may be utilized. All of these compounds are characterized by having the structural formula $R—CH=CH_2$, wherein R is a straight-chain alkyl redical containing from 3 to 8 carbons atoms. For the preparation of somewhat more preferred compounds of this invention, the alkyl group should contain from 3 to 5 carbon atoms. When these alpha-olefins are dimerized in accordance with the method to be described, there is obtained dimers having from 10 to 20 carbon atoms and, in the case of the preferred range, from 10 to 14 carbon atoms.

The alpha-olefins are dimerized by the use of an organo-aluminum catalyst of the so-called Ziegler type. In particular, catalysts having the formula $Li_mAlR''_nH_{m+3-n}$, wherein Li is lithium, Al is aluminum, R″ is a hydrocarbyl group, H is hydrogen and *m* may have a value of 1 or zero. When *m* is 1, *n* is zero; and when *m* is zero, *n* may be 1, 2, or 3. Specifically, the catalysts included are $LiAlH_4$ (lithium aluminum hydride), AlR''_3 (aluminum trihydrocarbyl), $AlR''H_2$ (aluminum dihydrocarbyl hydride), $AlR''H_2$ (aluminum hydrocarbyl dihydride). The preferred organo-aluminum compounds are the aluminum trihydrocarbyl and lithium aluminum hydride. The aluminum trihydrocarbyls are preferably aluminum trialkyls having from 1 to 18 carbon atoms in the alkyl radical, although other hydrocarbon substituents may be utilized such as aryl radicals, alkaryl radicals, and aralkyl radicals. It is preferred that these hydrocarbyl radicals have from 6 to 8 carbon atoms each; and in the aluminum trialkyls, it is particularly preferred that each alkyl radical have from 2 to 4 carbon atoms. The following specific compounds are examples of the aluminum trihydro-

carbyls which may be employed as the catalysts: aluminum trimethyl, aluminum triethyl, aluminum tripropyl, aluminum tributyl, aluminum triisobutyl, aluminum diethyl methyl, aluminum diethyl propyl, aluminum diethyl isobutyl, aluminum triphenyl, aluminum tribenzyl, aluminum trixylyl, aluminum diethyl phenyl, and aluminum tricyclohexyl. Other organo-aluminum compounds which may be utilized are the aluminum dihydrocarbyl hydrides such as aluminum diethyl hydride, aluminum dipropyl hydride, aluminum diisobutyl hydride, and the like. The preferred aluminum hydrocarbyl dihydrides which may be utilized are aluminum ethyl dihydride, aluminum propyl dihydride, and aluminum butyl dihydride. As has been pointed out, in lieu of the alkyl radicals, aryl, alkaryl, and aralkyl radicals also may be utilized in the hydrides and dihydrides.

These organo-aluminum catalysts may be prepared by well-known procedures. They should be prepared and handled in the absence of moisture and other harmful materials such as oxygen. This may be accomplished in accordance with established techniques employing a blanket of an inert gas such as nitrogen when preparing, handling, or transferring the catalyst.

The dimerization reaction is performed with the lithium aluminum hydride catalyst as a dispersion in the liquid alpha-olefin. The aluminum trihydrocarbyls and hydrocarbyl hydrides are usually in the form of a liquid which is soluble in the liquid hydrocarbon and, accordingly, may be used in that form. It is, therefore, unnecessary to utilize a diluent in the dimerization reaction since the liquid alpha-olefins themselves may be utilized either as the dispersion medium or solvent for the catalyst. The quantity of organo-aluminum catalyst may range from 1 percent to 20 percent by weight based on the weight of the alpha-olefin monomer.

The dimerization may be carried out at temperatures ranging from about 200° F. to 600° F., or somewhat higher in a continuous system. Preferably, reaction temperatures of from 250° F. to 500° F. are utilized. Reaction times are dependent on catalyst concentration and on the reaction temperatures employed. The lower concentrations and lower temperatures require longer times. The higher concentrations of catalysts and higher reaction temperatures utilize shorter reaction times. Times ranging up to 20 hours have been utilized to produce useful yields of dimers. At the end of the dimerization reaction, the dimer is fractionated from the catalyst at reduced pressures, i.e., at 10 mm. to 20 mm. of mercury. If it is unnecessary to recover the catalyst, as in laboratory-scale operations, the catalyst activity may be destroyed by the use of water, alcohol, or aqueous or alcoholic solutions of an acid. The dimer is then recovered by fractionation or filtration.

The dimers so produced are utilized to alkylate a benzene hydrocarbon. Suitable benzene hydrocarbons are benzene, toluene, any one or a mixture of the isomeric xylenes, ethylbenzene, n-propylbenzene, isopropyl benzene, diethyl benzene, and similar lower alkylated aromatics wherein the alkyl groups contain from 1 to 3 carbon atoms and there are preferably not more than 2 such groups on the benzene ring. The most preferred compound, however, is benzene. The alkylation reaction is carried out in the presence of a catalyst such as $AlCl_3$, HF, H_2SO_4, BF_3, or similar acid-type catalysts. Aluminum chloride is the preferred catalyst.

The alkylated benzene is thereafter sulfonated by conventional means utilizing concentrated sulfuric acid, SO_3, or oleum. For example, the alkylated benzene fraction is contacted with an approximately equal volume of 98 percent sulfuric acid and the mixture vigorously agitated to effect sulfonation at a temperature of 150° F. to 155° F., the reaction time being of the order of 15 to 30 minutes. Some variation in sulfonation conditions is permissible as is well-known, for example, the quantity of 98 percent sulfuric acid may vary between 0.9 and 1.1 volumes per volume of alkylated benzene fraction. The sulfonation temperatures may vary from 130° F. to 160° F. although temperatures of 150° F. to 155° F. are generally preferred. The sulfonation mixture is stripped of SO_2 by the use of steam, again in accordance with conventional procedures; and, if it is desired to de-oil and speed the settling of spent acid, the sulfonation mixture is admixed with from 3 to 10 volumes and preferably 3 to 5 volumes of an inert hydrocarbon solvent. This hydrocarbon solvent should boil below about 400° F., for example, aromatic solvents such as benzene, toluene, xylene, ethyl benzene, propyl benzene or cumene may be used. Paraffinic solvents such as hexane, heptane or petroleum naphthas also may be employed, as well as mixtures of aromatic and paraffinic solvents such as benzene-hexane mixtures.

The solvent aids in the clean separation of spent sulfonating agent which settles as a lower layer. The layers are separated and the solvent layer containing the sulfonic acids is contacted preferably with an aqueous alcohol solution to extract the sulfonic acids from the hydrocarbon solvent. The extracted sulfonic acids in aqueous alcohol solution are neutralized with a suitable base, for example, an aqueous solution of sodium hydroxide (preferably), potassium hydroxide, ammonium hydroxide, or an amine such as triethanolamine depending upon the sulfonate desired.

If desired, the neutralized sulfonic acids (sulfonate) may be re-extracted with the same hydrocarbon solvent (benzene-hexane, for example) to further de-oil the sulfonate. The hydrocarbon layer is separated from the aqueous alcohol layer containing the sulfonates; and the sulfonates are recovered by evaporating the alcohol, water and residual hydrocarbon solvents from them.

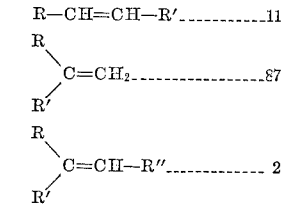
Instead of sulfonating with concentrated sulfuric acid, fuming sulfuric acid may be utilized, for example, 20 percent oleum, again in accordance with conventional methods. A temperature of from 90° F. to 95° F. is maintained with vigorous agitation while the oleum is added, and thereafter the mixture is heated to approximately 120° F. Reaction is continued with mixing at this temperature for approximately 90 minutes, then water is added to dilute the mixture and to provide a means of separating the spent acid. The upper layer containing the alkylated benzene sulfonic acids is separated by decantation and neutralized with a sodium hydroxide solution or similar basic solution, again in accordance with conventional practice. If desired, of course, the above-described procedure for neutralization, solvent extraction and de-oiling may be utilized.

In addition to testing the detergents made in accordance with this invention for their detergency and foaming tendencies as compared with conventional detergents, the compounds of this invention were also tested for their resistance to bacteriological degradation in comparison with similar detergents. The examples which follow are provided to illustrate the high susceptibility of the detergents of this invention to biological degradation as compared with detergents made in accordance with conventional methods.

EXAMPLE I

A C_{20} wax fraction (eicosane) was cracked to produce alpha-olefins, and a C_5 to C_7 cut was obtained by fractionation. The C_5 alpha-olefin constituted about 10 weight percent; the C_6, about 55 weight percent; and the C_7 alpha-olefin, about 24 weight percent of the mixture with the remainder of the mixture being slightly higher molecular weight olefins, with minor amounts of di-olefins, cyclo-olefins and aromatics. A 1699-gram sample of this alpha-olefin mixture was charged to a high pressure autoclave and 34 grams of lithium aluminum hydride catalyst was added, the autoclave having been purged with nitrogen and the catalyst added under a blanket of nitrogen. The temperature was raised

to 250° F. and held at that level for two hours and thereafter raised to 405° F.–420° F. and held at that level for 15.5 hours. A pressure of 340 p.s.i. was reached during this 405° F.–420° F. reaction period. At the end of the reaction period, the autoclave was cooled to 40° F., opened, and a 5 percent solution of HCl in water was added slowly in order to destroy the activity of the catalyst and stop the reaction. The hydrocarbon and catalyst were filtered and the product distilled to obtain a heart cut boiling between 397° F. and 553° F. which consisted predominatntly of C_{10} to C_{14} olefins. A hydrocarbon-type analysis (in volume percent) of this dimer product showed that the following olefins were produced:



wherein R, R′ and R″ are alkyl groups which may be the same or different.

These dimers were utilized to alkylate benzene in the presence of an aluminum chloride catalyst at a volume ratio of 6 volumes of benzene to 1 volume of dimer in order to produce the mono-alkylated product. The alkylated benzene was fractionally distilled to obtain a heart cut boiling between 516° F. and 644° F. This material had the following analysis in weight percent:

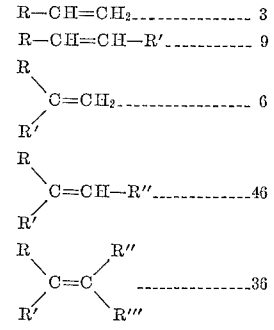
Paraffins	6
Cycloparaffins and olefins	2
Alkyl benzenes:	
Side chain C_{11}	5
Side chain C_{12}	35
Side chain C_{13}	37
Side chain C_{14}	9
C_nH_{2n-8} (alkenyl benzenes, indans, or tetralins)	6

It was also found that in the alkyl benzenes, a benzene ring carbon was attached to a secondary carbon of the alkyl side chain and that the benzene ring was attached predominantly to the second and third carbon atoms from the end of the chain of the alkyl side chain.

A 150-gram sample of the alkylated benzene was contacted with 157.5 grams of 20 percent fuming sulfuric acid. The acid was added to the alkylated benzene drop-wise while maintaining a temperature of from 90° F. to 95° F. with vigorous agitation. After all of the acid had been added, the mixture was heated to approximately 120° F. and held at this temperature with agitation for 90 minutes. Approximately 33 grams of water were added to the acid mixture with mixing and cooling to hold the temperature below about 135° F.

Two layers were obtained; and, after centrifuging the mixture for 15 minutes, the top layer was drawn off. A portion of this layer comprising 172 grams of the sulfonic acids was neutralized with 935 ml. of a 3 percent sodium hydroxide solution to a final pH of approximately 9.5. This neutral sulfonate was tested for cotton detergency and foam in comparison with a commercial dodecyl benzene sodium sulfonate prepared by the above-described method except that the alkyl group of the alkylated benzene instead of being derived from the alpha-olefin dimers was derived from commercial propylene polymer produced by the use of a phosphoric acid catalyst so that the alkyl radical of the dodecyl benzene sodium sulfonate had an average of approximately 12 carbon atoms.

The propylene tetramer used to prepare the commercial dodecyl benzene sodium sulfonate had the following hydrocarbon-type analysis (in volume percent):



wherein R, R′, R″ and R‴ are alkyl groups which may be the same or different.

The alkylated benzene sodium sulfonates are utilized commercially in "built" formulations. The compounds which are combined in with sulfonate and which augment its detergent properties are termed "builders" and include inorganic phosphates, silicates and sulfates together with a variety of other materials such as carboxymethyl cellulose. In testing the detergency characteristics of sulfonates thereof, a built formulation is utilized and the alkylated benzene sodium sulfonates are compared with a typical commercial standard built anionic-type detergent in a standardized cotton detergency test. The following typical built formulation was employed for testing the alkyl benzene sulfonates of this invention in comparison with the described commercial dodecyl benzene sulfonates produced from propylene tetramer.

30 weight percent of compound to be tested
40 weight percent sodium tripolyphosphate
22 weight percent sodium sulfate
7 weight percent sodium silicate
1 weight percent sodium carboxymethyl cellulose

The built formulations were tested in a standard Atlas Launderometer. The procedure and method of calculating detergency values differ only in minor detail from that described in "Carbon Soil Removal," P. T. Vitale et al., Soap and Chemical Specialties, vol. 32, No. 6, pp. 41–44 (June 1956) and are set forth below. The Launderometer consists of a spindle mechanism rotating in a hot water thermostated bath. Mason jars of one-pint capacity containing detergent, water, soiled cloth, and rubber balls for agitation are rotated on the spindle mechanism for a set time at a set rate in the hot water. The degree of cleaning is determined and the resulting numbers are the detergency values. These values are correlated with the standard anionic detergent to which an arbitrary detergency value is assigned.

The Launderometer tests are conducted according to the following method:

New Indian head cotton cloth is cut into 4-inch wide strips across the bolt. Six strips are rolled up together and extracted with 500 ml. of acetone for six hours in a Soxhlet extraction apparatus. The strips are removed and rinsed three times in distilled water, air dried until damp, ironed until completely dry, placed in a 200° F. oven for three hours, and finally stored in a dessicator until used.

A standard soil solution is prepared consisting of 2.7 grams commercial hydrogenated vegetable oil (trademarked Crisco), 9.3 grams U.S.P. grade mineral white oil, and 3 grams lampblack dissolved in 1500 ml. carbon tetrachloride. The hydrogenated vegetable oil, mineral white oil, and lampblack are mixed with approximately 250 ml. of carbon tetrachloride; the resulting concentrated soil slurry is passed through a small hand-operated homogenizer and the balance of the carbon tetra-

chloride added. In order to soil the cloth, about 200 ml. of the soil solution is placed in a 9-inch evaporating dish and each strip of cloth is passed lengthwise through this solution three times. The strips are hung to dry at room temperature for 1½ hours and then each strip is cut crosswise at 2-inch widths to give 2-inch by 4-inch swatches, each swatch being numbered. Each swatch is read four times, twice on each side, with a photometer using a magnesium carbonate block as the standard equal to 100 percent white. The average of the four readings is recorded as the soiled reflectance of each swatch. The reflectance readings of the cloth just prior to soiling are taken in the same manner and recorded.

All the samples are run in quadruplicate in jars placed around the axis of the launderometer wheel. A concentrated solution of the built formulation is made up so that the solids concentration is 5 percent. Tests may be run at the 0.2 weight percent, 0.3 weight percent, and 0.5 weight percent solids concentration level with the standard anionic detergent being run at the 0.3 weight percent solids concentration for the correlation to be described. The standard may also be run at 0.2 percent level or other levels merely for comparison purposes, but not for standardization.

When tests are conducted at the 0.2 percent solids concentration level, 4 ml. of the 5 percent by weight solution of the built formulation concentrate is added to each jar together with 10 three-eighth-inch diameter hard rubber balls, one soiled swatch and enough 300 parts per million hardness water, i.e., 96 ml., to make 100 ml. of solution having a concentration of 0.2 weight percent solids.

When operating at the 0.3 percent by weight solids level and 0.5 weight percent solids level, 6 ml. of the 5 percent concentrate and 10 ml. of the 5 percent concentrate, respectively, are added to each jar with 94 ml. and 90 ml., respectively, of hard water added to make the final solution. The jars are closed and rotated at 40–42 r.p.m. for 20 minutes at 120° F. The jars are removed immediately and the height of the foam above the solution in each jar is noted following one quick inversion of each jar. The swatches are then removed from the jar, rinsed with warm running water, air dried on paper, and read photometrically as has been described. The average of the four readings is recorded as the laundered reflectance. The detergency is calculated in the following way:

$$\text{Raw detergency} = \frac{R-S}{V-S} \times 100 = L$$

R=photometric percent reflectance of the washed cloth
S=photometric percent reflectance of the soiled cloth
V=photometric percent reflectance of the cloth before soiling
S usually ranges from 18 to 24
V is practically a constant at 87
R varies from 40 to 80

The L value is related to a standard value by a factor to give the final detergency.

$$\text{Final detergency} = D = L \times \frac{S_t}{L_s}$$

where

S_t=the arbitrary detergency of the standard,
L_s=the L (raw detergency) value for the standard which is always run concurrently with the material being tested.

An arbitrary detergency value (S_t) of 70 is assigned to the standard anionic detergent at the 0.3 percent solids level which is employed as the standard.

The results obtained in the detergency tests run on the alkyl benzene sodium sulfonates produced from the alpha-olefin dimer of this example and with a commercial dodecyl benzene sodium sulfonate produced from the propylene tetramer described are set forth in Table I.

Table I

Solids Concentration, Weight Percent	0.2		0.3		0.5	
	D	F	D	F	D	F
Dodecyl Bezene Sodium Sulfonate	68	20	68	22	------	------
Alpha-Olefin Dimer Benzene Sodium Sulfonate	75	20	73	19	73	23

D=Final detergency.
F=Foam height in one-eighth inches (e.g. 31=2⅝ inches).

These results demonstrate clearly that the detergents of this invention have excellent detergency properties.

Another portion of the alkyl benzene sodium sulfonate prepared from the alpha-olefin dimer of this example was tested for its resistance to bacteriological degradation in comparison with the commercial dodecyl benzene sodium sulfonate made from phosphoric acid catalyzed propylene tetramer.

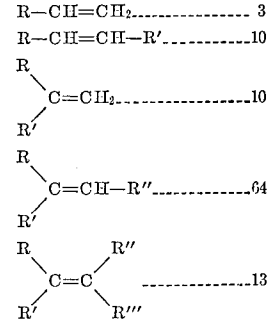
In this test, natural, raw river water having a normal bacteria population is utilized. A sufficient quantity of the detergent is added to make up a solution containing 5 parts per million of the detergent in the river water for the first solution, and for the second solution a sufficient quantity of detergent is added to make up 20 parts per million of the detergent in the river water. The water is tested immediately for its detergency content by the "methylene blue" test as described in the article by Degens et al., Journal of Applied Chemistry, volume 3, page 54 (1953). Each solution is tested periodically to determine the rate at which the detergent is being degraded by the bacteria contained in the water. After 16 days, 95 percent of the alkylated benzene sodium sulfonate produced from the alpha-olefin dimer had disappeared whereas only 40 percent of the propylene tetramer commercial dodecyl benzene sodium sulfonate had disappeared. At the end of 30 days, all of the alpha-olefin dimer-type detergent had disappeared, whereas only 50 percent of the propylene tetramer product had disappeared.

EXAMPLE II

In order to demonstrate the criticality of utilizing dimers made by the organo-aluminum catalysts in the production of alkyl benzene sulfonates having a high susceptibility to bacteriological degradation, for comparison, alkyl benzene sulfonates were made wherein the alkyl group was derived by dimerizing alpha-olefins with a phosphoric acid catalyst.

Alpha-olefins produced by the cracking of wax (as in Example I) were dimerized over a commercial phosphoric acid catalyst supported on kieselguhr.

This product was fractionated to obtain a C_{10} to C_{14} fraction which had the following hydrocarbon-type analysis.



wherein R, R', R'' and R''' may be the same or different alkyl groups.

This dimer fraction was utilized to alkylate benzene using an aluminum chloride catalyst as in Example I to produce a product (after fractionation) which had a boil-

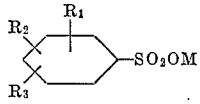
ing range from 572° F. to 606° F. and had the following analysis.

Paraffins	2
Cycloparaffins and olefins	12
Alkyl benzenes:	
Side chain C_{11}	10
Side chain C_{12}	32
Side chain C_{13}	27
Side chain C_{14}	4
C_nH_{2n-8} (alkenyl benzenes, indans, or tetralins)	13

The alkylated benzene was sulfonated with oleum and the sodium salt produced in the same manner as described in Example I. The sodium sulfonate had a detergency of 66 and a foam of 19 at a solids concentration of 0.3 weight percent in water. When tested for its susceptibility to bacteriological degradation in the same manner as described for the sulfonates in Example I, after 30 days, 77 percent remained undecomposed compared with 50 percent for the same propylene tetramer product utilized in Example I which was run in this experiment for comparison.

We claim:

1. Alkylated benzene sulfonates having a high susceptibility to bacteriological degradation, said sulfonates having the formula

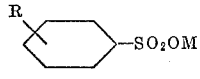


wherein M is selected from the group consisting of the alkali metals and ammonium, R_1 is selected from the group consisting of hydrogen and an alkyl radical having from 1 to 3 carbon atoms, R_2 is selected from the group consisting of hydrogen and an alkyl radical having from 1 to 3 carbon atoms, R_3 is an alkyl radical having from 10 to 20 carbon atoms produced by contacting straight-chain alpha-olefins having the structural formula

$$R'—CH=CH_2$$

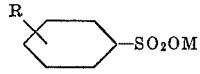
wherein R' is an alkyl radical having from 3 to 8 carbon atoms, with from 1 percent to 20 percent by weight based on the weight of said alpha-olefins of a $LiAlH_4$ catalyst at a temperature in the range of from 200° F. to 600° F. under autogenous pressure and recovering a C_{10} to C_{20} olefin fraction.

2. Alkylated benzene sulfonates having a high susceptibility to bacteriological degradation, said sulfonates having the formula



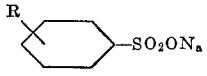
wherein M is selected from the group consisting of the alkali metals and ammonium, R is an alkyl radical having from 10 to 20 carbon atoms produced by contacting straight-chain alpha-olefins having the structural formula $R'—CH=CH_2$, wherein R' is an alkyl radical having from 3 to 8 carbon atoms with from 1 percent to 20 percent by weight based on the weight of said alpha-olefins of a $LiAlH_4$ catalyst at a temperature in the range of from 200° F. to 600° F. under autogenous pressure and recovering a C_{10} to C_{20} olefin fraction.

3. Alkylated benzene sulfonates having a high susceptibility to bacteriological degradation, said sulfonates having the formula



wherein M is selected from the group consisting of the alkali metals and ammonium, R is an alkyl radical having from 10 to 14 carbon atoms produced by contacting straight-chain alpha-olefins having the structural formula $R'—CH=CH_2$, wherein R' is an alkyl radical having from 3 to 5 carbon atoms with from 1 percent to 20 percent by weight based on the weight of said alpha-olefins of a $LiAlH_4$ catalyst at a temperature in the range of from 200° F. to 600° F. under autogenous pressure and recovering a C_{10} to C_{14} olefin fraction.

4. Alkylated benzene sodium sulfonates having a high susceptibility to bacteriological degradation, said sulfonates having the formula



wherein R is an alkyl radical having from 10 to 14 carbon atoms produced by contacting straight-chain alpha-olefins having the structural formula $R'—CH=CH_2$, wherein R' is an alkyl radical having from 3 to 5 carbon atoms with from 1 percent to 20 percent by weight based on the weight of said alpha-olefins of a $LiAlH_4$ catalyst at a temperature in the range of from 200° F. to 600° F. under autogenous pressure and recovering a C_{10} to C_{14} olefin fraction.

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