

UNITED STATES PATENT OFFICE

2,676,987

BIS-ALKYL BENZYL QUATERNARY
AMMONIUM SALT

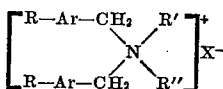
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This invention relates to the preparation of new and useful oil-soluble di-(alkyl aryl methylene) quaternary ammonium salts. These salts are

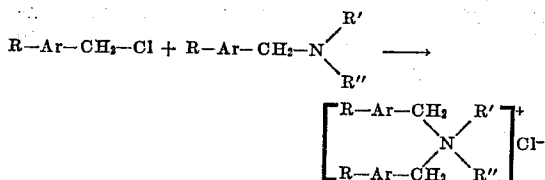
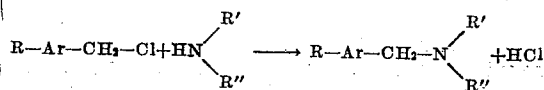


characterized by the general formula wherein R is an alkyl group of from 4 to 18 carbon atoms and Ar is an aryl hydrocarbon nucleus. R' and R'' are aliphatic, cycloaliphatic, aromatic or araliphatic substituents containing a maximum total of 12 carbon atoms which may be members of the same heterocyclic or cyclic ring. X is a salt-forming anionic radical. The compounds of this formula are preferentially oil-soluble and are further characterized in having outstanding fungicidal properties. They are also useful in the general control of micro-organisms such as bacteria, fungi, algae, and the like. The compounds are surface-active in nature and may be utilized in general applications wherever surface-active agents are employed.

The above compounds are conveniently prepared by reacting an alkyl aryl methylene halide such as the chloride with a secondary amine of the type formula



in which R' and R'' are aliphatic, cycloaliphatic, aromatic or araliphatic substituents containing a maximum total of 12 carbon atoms which may be members of the same heterocyclic or cyclic ring. The reaction is believed to proceed as follows:



The alkyl groups designated by the letter R in the foregoing equations and formulae may be any acyclic alkyl group from 4 to 18 carbon atoms. They may be obtained, for example, from any convenient source of olefins suitable for the alkylation of aryl hydrocarbons. Such olefins are those derived from cracked petroleum fractions,

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Fischer-Tropsch synthesis, polymers of ethylene, propylene, butylene, etc. as well as many other sources customarily employed in the production of alkylating agents. Instead of alkylating agents of the foregoing olefinic types, hydrocarbon fractions such as kerosene distillate may be chlorinated to produce chlorinated hydrocarbon mixtures suitable for condensing with the aryl hydrocarbon nucleus to give the desired alkyl group. The alkyl groups may also be obtained by condensing fatty alcohols of from 4 to 18 carbon atoms and mixtures thereof with the aryl hydrocarbon nucleus.

Although acyclic alkyl groups of the foregoing types are all satisfactory, those obtained from propylene polymers having from 6 to 15 carbon atoms are preferred since the oil-soluble quaternaries produced from them are very highly fungicidal. These polymers are the propylene dimers, propylene trimers, propylene tetramers and propylene pentamers. Mixtures of propylene polymers may also be employed and are very desirable due to their ready availability.

The aryl hydrocarbon nucleus of our novel di-(alkyl aryl methylene) quaternary ammonium salts as illustrated by the above equations and formulae may be any of the type such as benzene, naphthalene, anthracene, and the like. Short-chain alkyl substituted benzenes such as toluene, xylene, mesitylene, ethylbenzene, propylbenzene, etc. may also be employed. However, for present purposes the benzene nucleus is preferred.

The secondary amines employed in the preparation of our quaternary ammonium salts may be illustrated by compounds having low molecular weight alkyl groups of the type such as methyl, ethyl, propyl, etc. attached to the nitrogen atom. Such amines are, for example, dimethylamine, diethylamine, dipropylamine, methylethylamine, etc. Alkanol secondary amines such as β -hydroxy ethyl methyl amine, diethanol amine, etc. are also suitable. The secondary amines may also be heterocyclic in nature as illustrated by compounds such as morpholine, piperidine, etc. Benzyl methyl amine, N-methyl aniline, cyclohexyl methyl amine and other such araliphatic, cycloaliphatic or aromatic secondary amines are further examples of suitable amines for this invention.

The alkyl aryl methylene halides employed in preparing the di-(alkyl aryl methylene) quaternary ammonium salts, according to our invention, may be produced by various methods known to the art. One very suitable method is that in which an aromatic hydrocarbon such as benzene

is first condensed with a propylene polymer having the desired number of carbon atoms. A catalyst such as a hydrofluoric acid catalyst is usually employed and the condensation is carried out at temperatures of from about 0° F. to 125° F. Other catalysts such as BF₃ and HF, aluminum chloride, sulfuric acid, etc. may also be used in the condensation. The alkyl aromatic product of the condensation is then chloromethylated by reacting it with formaldehyde and hydrochloric acid or paraformaldehyde and hydrogen chloride in the presence of a catalyst such as zinc chloride, concentrated sulfuric acid, acetic acid, etc. The chloromethylation is generally accomplished at ordinary temperatures ranging from about 20° C. to about 100° C.

In the foregoing process of preparing the alkyl aryl methylene halides, other alkyl aromatic hydrocarbons may be used. For example, mixtures of alkyl aromatic hydrocarbons such as those obtained by solvent extraction or SO₂ extraction of various petroleum fractions may be conveniently chloromethylated to give a very suitable mixture of alkyl aryl methylene halides.

Suitable alkyl aryl methylene halides may also be derived by means other than by the chloromethylation of alkyl aromatic hydrocarbons. For example, chlorinated alkyl aryl methylene chlorides, such as tetrachlorododecyl benzyl chloride, may be obtained by direct chlorination of dodecyl toluene in accordance with copending U. S. patent application No. 134,139, filed December 20, 1949.

The alkyl aryl methylene halides having the desired characteristics as described above are readily condensed with the secondary amines to produce the di-(alkyl aryl methylene) quaternary ammonium salts of our invention. A molar excess of the alkyl aryl methylene halide is employed to insure conversion of the intermediate alkyl aryl methylene tertiary amines to the quaternary ammonium compound. For convenience, the reactants are usually mixed with a solvent such as methanol and water. Although the reaction proceeds at room temperature, it may be desirable to warm the reaction mixture to temperatures of from 25° C. to about 100° C. to accelerate the reaction. A neutralizing agent such as sodium carbonate, lime, or sodium bicarbonate is desirable in the reaction mixture to neutralize the acids formed during the conversion of the secondary amine to the intermediate alkyl aryl methylene tertiary amine. When the reaction is complete, the di-(alkyl aryl methylene) quaternary ammonium product may be easily separated from the reaction mixture by withdrawing the water layer and evaporating the solvent. Other separating means such as filtration, decanting, etc. in conjunction with various washing procedures may also be employed. If desired, the product may be further purified by redissolving it in a solvent, such as methanol and water and extracting it with mineral spirits, such as petroleum ethers to remove unreacted hydrocarbons.

Although in the preceding discussion reference has been made to the halides, and chloride in particular, any anionic radicals capable of yielding salts may be present in the quaternary ammonium salts according to our invention. Such anionic salt-forming radicals, for example, are hydroxyl, nitrate, sulfate, phosphate, carbonate, alkyl sulfates such as methosulfate, etc., alkyl phosphate, formate, acetate, and the like. These radicals may be suitable, obtained, for example, by metathesis of the halide salts with appropriate

salts of the desired anionic radicals. However, halide radicals, particularly the chloride radical, are presently preferred.

The following examples are offered in illustration of the invention, but are not to be considered in limitation thereof.

Example 1.—Preparation of N,N-dialkylbenzyl N,N-dimethyl ammonium chloride

A mixture of 334 parts of alkylbenzyl chloride having as its alkyl group a propylene polymer mixture containing from 12 to 15 carbon atoms, 42 parts of dimethylamine hydrochloride, 200 parts of methanol, 84 parts of sodium bicarbonate and 50 parts of water was heated with stirring at 60° C. for 2 hours, then at 70° C. for 5 hours. The water layer was removed and the product layer was washed with 200 parts of water. The product was then concentrated in vacuo to give a pale yellow, viscous semisolid.

20 parts of the above product were dissolved in 200 parts of methanol and 10 parts of water. After extracting the solution with four 100 ml. portions of petroleum ether, the solvents were evaporated to give a tacky, pale-yellow solid which was insoluble, but dispersible in water, and soluble in organic solvents such as alcohol, acetone and benzene. The material possessed the following inspections:

	Found	Theory
Percent Nitrogen.....	2.51	2.30
Percent Chlorine.....	5.85	5.84

Example 2.—Preparation of N,N-dialkylbenzyl morpholinium chloride

A mixture of 350 parts of alkylbenzyl chloride, similar to that employed in the preceding example, 43 parts of morpholine, 45 parts of sodium bicarbonate, 150 parts of methanol and 50 parts of water was refluxed with stirring for 4½ hours. The mixture was cooled and then worked up in the same manner as in Example 1 to give a tan-colored, glassy solid which possessed the following inspections:

	Found	Theory
Percent Nitrogen.....	2.05	2.15

The preparation of the corresponding quaternaries using diethylamine and diethanolamine were carried out in a similar manner. The proportions referred to in the examples were taken on a weight basis unless otherwise specified.

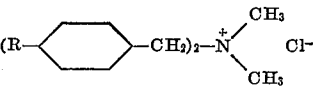
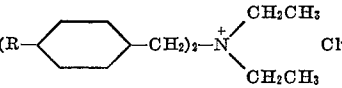
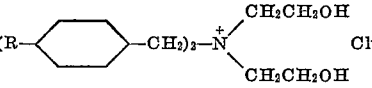
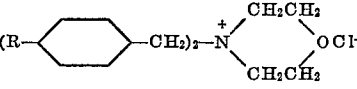
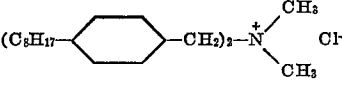
The germicidal activity of the compounds prepared in the foregoing examples was determined by testing their effectiveness against several different micro-organisms customarily employed in evaluating quaternary ammonium compounds. The results of these tests are set out in Table I which follows.

Example 3.—Preparation of N,N-dioctylbenzyl N,N-dimethyl ammonium chloride

A mixture of 24 parts of para-octylbenzyl chloride (2-para-chloromethylphenyl octane), 4.4 parts of dimethylamine hydrochloride, 30 parts of methanol, 3 parts of calcium oxide and 10 parts of water was heated under reflux conditions for five hours. After cooling, the water layer at the bottom was drawn off. The product layer was further diluted with 50 parts of meth-

anol and then washed successively with water, dilute hydrochloric acid, 2% sodium bicarbonate solution, and twice with water. The resultant methanol solution was evaporated under a vacuum to give a clear, colorless, glassy solid having germicidal activity as noted in the following table.

TABLE I.—GERMICIDAL ACTIVITIES OF OIL-SOLUBLE QUATERNARIES

Compound (R is a C ₁₂ –C ₁₅ Propylene Polymer)	Phenol Coefficient		Maximum Effective Dilution <i>Trichophyton rosaceum</i>
	<i>Staphylococcus aureus</i>	<i>Salmonella typhosa</i>	
	350	210	1:10,000
	170	120	1:5,500
	380	—	—
	150	—	—
	1,000+	—	—
Phenol.....	1	1	1:85

ternary ammonium salt has a maximum effective dilution of only about 1:4,000, showing it to be less than one-half as effective as the oil soluble salt. This effect is altogether unexpected since it has been heretofore believed, as stated at page 75 of the book by Lawrence entitled "Quaternary

The phenol coefficients in the above table illustrate the killing power of the various oil-soluble quaternary ammonium salts tested against the bacteria specified. They were obtained by the method outlined in the U. S. Food and Drug Administration Tests published in U. S. Department of Agriculture Circular 198, December 1931. The evaluations were carried out at 20° C. and Lethen broth was used in the subculture to prevent bacteriostasis. The maximum effective dilutions referred to in the table were determined according to the method of testing outlined in U. S. Navy Department Specification 51D6 Circular 198. The results are given in parts by weight of oil-soluble quaternary in water necessary to kill the fungus *Trichophyton rosaceum* in 10 minutes. The greater maximum effective dilution values are indicative of the most effective destruction of fungus.

It will be noted from the results set out in the foregoing table that the various oil-soluble di-(alkyl aryl methylene) quaternary ammonium salts of this invention are characterized over-all by excellent germicidal activity against a variety of microbiological organisms. However, it is readily apparent that the outstanding characteristic of these oil-soluble quaternaries is their extremely high fungicidal activity.

The unusually high degree of fungicidal activity inherent in the oil-soluble quaternaries of this invention is conveniently illustrated by comparing the oil-soluble di-(alkyl benzyl) dimethyl quaternary ammonium chloride with a water-soluble alkyl benzyl trimethyl ammonium chloride having as its alkyl group a propylene polymer of from 12 to 15 carbon atoms. Whereas the oil-soluble salt as disclosed in the preceding table has a maximum effective dilution value of 1:10,000, the corresponding water-soluble qua-

Ammonium Germicides" (published 1950 by The Academic Press, Inc., New York, N. Y.), that in a given series of quaternary ammonium salts the effect of increasing the number of carbon atoms of the oil-soluble group was to cause the germicidal activity of the salt to decrease rapidly.

The unexpectedly superior germicidal and fungicidal activity of our oil-soluble quaternary ammonium salts over the corresponding water-soluble salts as illustrated above makes them particularly desirable in applications such as the inhibition of molds, algae, fungi, etc. when the less active water-soluble quaternaries have been only moderately effective. Although the quaternary ammonium salts of our invention are preferentially oil-soluble, they may be dispersed in water solutions at use concentrations of, for example, from about 1 to 200 p. p. m. If desired, the oil-soluble di-(alkyl aryl methylene) quaternary ammonium salts may be mixed with other quaternaries, such as the water-soluble alkyl aryl methylene quaternary ammonium salts to give a very versatile and effective germicidal composition having greatly enhanced properties for the killing and control of molds, algae, fungi, and the like, under stringent conditions.

A further and very fundamental distinction of the quaternary ammonium salts of our invention over the water-soluble quaternary ammonium compounds lies in the fact that they are readily soluble in oil. Because of this characteristic, the present compounds are adaptable to the production of mineral oil and vegetable oil solutions and emulsions having bactericidal, fungicidal and algacidal properties. Such solutions are valuable in the treatment of leather, textiles, wood and surfaces in general such as hospital floors, etc. wherever it is desirable to cut down on the spreading of microbial infections and diseases. Water-

soluble quaternary ammonium salts have not been entirely satisfactory for these purposes inasmuch as it is necessary to use them in the form of water and oil emulsions which are difficult to stabilize.

The preferentially oil-soluble di-(alkyl aryl methylene) quaternary ammonium salts of this invention, in addition to being effective germicidal agents, possess surface-active properties when render them suitable for various other uses. Such uses, for example, may be as lubricating and fuel oil additives, cationic emulsifiers, corrosion inhibitors, dye substantivity improvers, asphalt anti-stripping agents, dispersants in oil base drilling muds for oil wells, as well as many other applications.

Numerous variations and modifications of this invention will be apparent to those skilled in the art from the foregoing disclosure. This invention contemplates all such variations and modifications as coming within the scope of the appended claim.

We claim:

Oil soluble N,N-di-(alkyl benzyl) N,N-diethanol

quaternary ammonium chlorides in which the alkyl group is derived from a propylene polymer mixture containing from 12 to 15 carbon atoms per molecule.

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