QUATERNARY AMMONIUM ACINITRO COMPOUNDS


1. Claim. (Cl. 260—286)

This invention relates to the preparation of relatively water-insoluble, biocidically active compounds obtained by the reaction of water-soluble, biocidically active quaternary ammonium compounds with water-soluble salts of aliphatic nitro compounds containing four to twenty-four carbon atoms. This is a continuation-in-part of co-pending application Ser. No. 352,675, filed Mar. 17, 1964, now abandoned.

Nitro compounds which may be used in this invention correspond to the following formula:

\[
O \quad \text{RCH} = \bigcap \text{N—OZ}
\]

where \( R \) and \( R^1 \) may be branched or straight chain aliphatic, alicyclic, aromatic, heterocyclic radicals or combinations thereof. In general, any nitro compound containing four to twenty-four carbon atoms in which the carbon atom bearing the nitro group also has at least one hydrogen atom may be used. Tertiary nitro compounds such as 2-nitro-2-methyl propane may not be used. Examples of suitable nitro compounds which may be used include primary and secondary nitroaraffins containing four to twenty-four carbon atoms, nitro olefins, nitro alcohols and their derivatives containing four to twenty-four carbon atoms, beta-nitrostyrene, phenyl nitromethane and the like.

The compounds of this invention can be prepared by mixing an aqueous solution of a water-soluble salt of the nitro compound with an aqueous solution of a quaternary ammonium salt salt having biocidically active properties. The two solutions are thoroughly mixed and are then allowed to stand until they separate into two distinct layers. The upper layer will normally contain the compound of the present invention. Layer separation is conveniently effected by conducting the reaction in a separatory funnel and drawing off the desired layer. The product usually contains some water which can be removed by distillation or drying in a vacuum oven. The aqueous product layer can, however, be used directly in any process where the entrapped water would not be harmful.

Many of the nitro compounds that can be used in this reaction are available commercially. The Commercial Solvents Corporation, for example, manufactures 2-nitro-1-butanol. Those not commercially available can be readily synthesized by well-known methods. For example, the preparation of a variety of nitro compounds is described by N. Kornblum in "Organic Reactions," volume 12, pages 101—156 (John Wiley 1962).

Typical examples of the quaternary ammonium compounds which may be used in this invention are the alkyl trimethyl ammonium chlorides, alkyl-benzyl trimethyl ammonium chlorides, alkyl dimethyl benzyl ammonium chlorides, alkyl dimethyl monomethyl ammonium chlorides, alkyl dimethyl substituted-benzyl ammonium chlorides in which the benzyl radical is substituted with one or more side chains containing from one to five carbon atoms such, for example, as methyl, dimethyl, ethyl and the like and in which the carbon atoms may all be in the same or different side chains or in which the benzyl radical bears one, two or more halogen atoms such as chlor-
or convoluted materials, involves a two-step process. In the first step, the material is passed through a bath containing the anionic moiety. Excess solution is removed by methods well known to those skilled in the art. The treated material is then passed through a second bath wherein the aqueous ammonium compound reacting with the anionic moiety, depositing the product in the most intimate way on the surface and in the interstices, convolutions and reticulations of the material.

The adjustment of solution concentration to achieve the required pickup is well known to those skilled in the art. The order of treatment may be reversed without affecting the biological activity or durability of the product on the material. The products of this invention may be formulated as water dispersions by dissolving them in a water-miscible organic solvent such as acetone or methanol and diluting with water or by dissolving them in emulsifiable oils such, for example, as sulfonated castor oil or pine oil and diluting with water. In preparing aqueous dispersions, emulsifying agents such, for example, ethylene oxide condensates of polyethylene oxide phenols may be used with or without organic solvents.

It is surprising that the compounds of this invention exhibit high microbiocidal activity despite their relative insolubility in water. Because of their unusual combination of physical and microbiological properties, they can be used to impart laundry-resistant anti-microbial characteristics to textiles. They can also be used as the active agent in anti-mildew finishes for textiles which are resistant to leaching with water.

Although the compounds have low water solubility, they are compatible with various organic solvents, plasticizers and high molecular weight compounds. Consequently, they may be incorporated as anti-microbial agents in synthetic resins and plastics. The compounds are compatible with natural and synthetic rubber latices. Therefore, they may be used to prepare bactericidal films and molded objects deposited from such latices.

The compounds can be incorporated into cutting and grinding fluids without precipitation. Also, they blend well with non-ionic and anionic surface active agents. In such compositions they retain their microbiocidal activity.

The compounds of this invention also possess effective antistatic properties and may be incorporated in or used as a coating upon any product that is subject to static electricity. For example, they may be used to coat or impregnate wood, paper, ceramics, natural or synthetic polymers, etc. They may be coated upon the surface of such product or intermixed with the components of a molded, cast or extruded product.

It will be understood that the properties of the products described herein will vary depending upon the nature of the cationic quaternary ammonium compound used in their preparation as well as the anionic compound reacted therewith.

The chemical, physical and biological properties of the products of our invention make them especially appropriate for the following applications when suitably incorporated in active amounts in an appropriate vehicle, binder, medium or substrate:


2. Paint mildewstabs.

3. Jet plane fuel additive to control growth of microorganisms.

4. Odor preservative agents for clothes and shoes.

5. Mildew retardant and odor suppressant for shoes and other leather products.

6. Topical antiseptics.

7. Antidandruff agents.

8. Disinfection agents for hair and gut of man and beast.

9. Bacteriostatic furniture dressing.

10. Surface finishes for stone, plaster, tile, cement, brick and other inorganic building materials to retard growth of microorganisms, fungi, mold and algae.


12. Pigment suspension of ionomeric ammonium compounds to combat fungi.


15. Mildewproofing agent in and on plastic and film.


17. Contact biostat for application to film, waxes and cloth to preserve cheese, meats and vegetables and other food products.

18. Algal inhibition, especially on surfaces and in solution where low foaming is desirable.


20. Sanitizing agent for rug, carpet, curtains.


22. Adhesive preservation.

23. Preservation of latex paints.

24. Preservation of metal-working compounds.

25. Additives for soaps and for both anionic and non-ionic detergents in liquid, bar, powder, bead, solution and other forms to impart bacteriostatic and fungicidal properties thereto.


The microbiocidal activity of our compounds has been evaluated for microbiological stasis by the Standard Tube Dilution Test, the technique for which is common knowledge to those skilled in the art. A Difco Bacto CSMA Broth #0826 was used in the study. This test is used to determine the lowest concentration of microbiologically active compounds which will inhibit the growth of the organism in question. For a wide range of applications, the inhibition of growth rather than outright kill is satisfactory.

Briefly put, the Tube Dilution Test consists in placing 9 cc. of the CSMA Broth in a test tube which is then sterilized in an autoclave. One cc. solution of the microbiologically active compound at an appropriate concentration is added to the test tube which is then incubated at 31°C. for forty-eight hours and observed for bacterial growth.

The same procedure is followed for fungi. In such tests, however, the tubes are incubated for fourteen days at a temperature suitable for optimum fungal growth, usually 25°C.

The invention is illustrated by, but not restricted to, the following examples:

EXAMPLE I

A 10% aqueous solution of the sodium salt of nitrocyclohexane, which may be made by reacting cyclohexane with dilute nitric acid and which is also available commercially from the Aldrich Chemical Co., Inc. Milwaukee, Wis., was prepared, and 130 grams of this solution was placed in a separatory funnel. To this solution was added 350 grams of a 10% solution of lauryl isoinquolinium bromide (Onyx Chemical Corporation's "Isothan Q-75") and 100 ml. of benzene. The funnel was shaken and then layer separation allowed to occur. The benzene layer was separated and dried first on a steam bath and then in a vacuum oven to give 38 grams (99% yield) of a dark red syrup of lauryl isoinquolinium nitrocyclohexane enolate.

EXAMPLE II

An additional 130 grams of the nitrocyclohexane solution described in Example I was placed in a separatory funnel and 330 grams of a 10% solution of dialkyl dimethyl ethylbenzyl ammonium chloride (Onyx Chemical Corporation's "BTC-471"); alkyl distribution: C12, 50%;
3,419,562

C₁₄, 30%; C₁₆, 17%; C₁₈, 3% was added along with 100 ml of benzene. The funnel was shaken and the benzene layer separated and dried to give 37 grams (89% yield) of a yellow paste of alkyl dimethyl ethylbenzyl ammonium nitrocyclohexane enolate.

EXAMPLE III

160 grams of a 10% solution of the potassium salt of 1-nitrododecane, which may be prepared similarly to the nitrocyclohexane of Example 1, was placed in a 1 liter separatory funnel together with 260 grams of a 10% solution of the quaternary ammonium compound shown in Example II. After 100 ml of benzene was added, the funnel was well shaken. Layer separation was allowed to occur and the benzene layer separated and dried to give 35 grams (97% yield) of an orange paste of alkyl dimethyl ethyl benzyl ammonium nitrododecane enolate.

To an additional 100 grams of the nitrododecane solution was added a chemically equivalent amount of alkyl dimethyl benzyl ammonium chloride (Onyx Chemical Corporation's "BTC-824"; alkyl distribution: C₁₂, 60%; C₁₄, 30%; C₁₆, 5%; C₁₈, 5%). Benzene was added and the solutions mixed. The product was worked up as above to give 149 grams (100% yield) of a yellow paste of alkyl dimethyl benzyl ammonium nitrododecane enolate.

Using the quaternary ammonium compound of Example I, a dark viscous liquid of lauryl isquinolinium nitrododecane enolate, in 98% yield, was obtained from 1-nitrododecane.

EXAMPLE IV

To 1 mol of undecenyl alcohol containing 0.5 cc. of pyridine and kept in an ice-salt mixture, there was added slowly, with stirring, 2 mols of thionyl chloride. The mixture was heated at 135°-145° C. until evolution of sulfur dioxide ceased. The excess of thionyl chloride was distilled off under diminished pressure and the residue was washed first with saturated aqueous sodium chloride solution, then with 10% aqueous sodium carbonate solution, and, finally, again with the sodium chloride solution. The oil was taken up in ether, the solution was dried and distilled under reduced pressure to yield 83% of 10-undecene 1-chloride. This product was reacted with silver nitrite in the manner described in "The Journal of the American Chemical Society," vol. 51, page 279 (1929), to obtain 1-nitro-10-undecene. This product was then brominated with benzene and water to obtain 1-nitro-10,11-dibromundecane, which was then dehydrobrominated by the action of caustic potash to potassium salt of 1-nitro-10,11-undecyce.

Stoichiometric amounts of the 1-nitro-10,11-undecyene and "BTC-471 (disclosed in Example II)" were reacted in the same manner, and using the same procedures as in Example II, to yield a dark, viscous product identified as alkyl dimethyl ethylbenzyl ammonium 1-acnitromundecyne.

EXAMPLE V

A 10% solution of the sodium salt of 2-nitro-1-butanol was prepared and reacted with a chemically equivalent amount of a 10% solution of lauryl isquinolinium bromide. Extraction with benzene and drying yielded a 100% yield of a red-brown paste of lauryl isquinolinium 2-nitro-1-butanol enolate.

EXAMPLE VI

Using the general procedure and the quaternary ammonium compounds of Examples I-IV, the potassium salt of beta nitrostyrene was reacted with lauryl isquinolinium bromide (red paste—98% yield), alkyl dimethyl benzyl ammonium chloride (orange paste—61% yield) and alkyl dimethyl ethyl benzyl ammonium chloride (orange solid—98% yield).

The latter two derivatives were subjected to the Agar Plate Test to determine zones of inhibition of growth against Staphylococcus aureus (S.a.), Salmonella typhosa (S.t.) and Aspergillus niger (A.n.). Zones were obtained as shown in Table I.

TABLE I

<table>
<thead>
<tr>
<th>Product form</th>
<th>Zones of Inhibition, mm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.a.</td>
<td>S.t.</td>
</tr>
<tr>
<td>Alkyl dimethyl ethylbenzyl ammonium chloride</td>
<td>10.8</td>
</tr>
<tr>
<td>Alkyl dimethyl benzyl ammonium chloride</td>
<td>25.25</td>
</tr>
</tbody>
</table>

EXAMPLE VII

Two of the quaternary-nitro aliphatic reaction products were run against Desulfovibrio desulfuricans according to the procedure outlined in the report of the American Petroleum Institute Subcommittee on Biological Analysis of Injection Waters To Be Used for Water Flood Purposes (March 17, 1958).

EXAMPLE VIII

Using the Standard Tube Dilution Test described above, the following bacteriostatic levels were determined (S.a. = Staphylococcus aureus; S.t. = Salmonella typhosa; A.n. = Aspergillus niger):

<table>
<thead>
<tr>
<th>Product form</th>
<th>Bacteriostatic dilution level vs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.a.</td>
<td>S.t.</td>
</tr>
<tr>
<td>Example I</td>
<td>10³</td>
</tr>
<tr>
<td>Example II</td>
<td>10³</td>
</tr>
<tr>
<td>Example IV</td>
<td>10³</td>
</tr>
</tbody>
</table>

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

The invention claimed is:

1. A quaternary ammonium compound having a quaternary cation selected from the group consisting of alkyl dimethyl benzyl ammonium, alkyl dimethyl ethylbenzyl ammonium and alkyl isquinolinium, wherein the alkyl, in each instance, has 12 to 18 carbon atoms, and having an anion selected from the group consisting of mono-nitrocyclohexane, 1-acnitrododecane, 2-acnitro-1-butanol, beta-acnitrostyrene and 1-nitro-10,11-undecyne.

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260—290, 247, 632, 644, 326.85, 567.6, 645, 501; 1—116.2, 128; 99—161, 222; 252—8.55, 8.57, 51, 107, 175; 162—8; 106—3, 15; 167—13, 33, 38.5, 43, 42, 58, 50, 87