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French et al.

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[54] **ULTRAVIOLET LIGHT BLEACHING OF CARBOXYLIC ACID ESTERS AND EPOXY COMPOUNDS**

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[52] U.S. Cl. ....204/158 R

[51] Int. Cl. ....B01J 1/10

[58] Field of Search.....204/158

[56] **References Cited**

**UNITED STATES PATENTS**

1,948,281 2/1934 Smith.....204/158  
2,647,868 8/1953 Dean .....204/158

Primary Examiner—Howard S. Williams  
Attorney—Walter H. Schneider

[57] **ABSTRACT**

A process of bleaching carboxylic acid esters and/or epoxy compounds by irradiating the esters and/or epoxy compounds with ultraviolet light in the presence of ketone. The preferred compounds bleached are the epoxidized higher fatty acid esters. Benzophenone, acetophenone, and acetone are examples of some suitable ketones.

17 Claims, No Drawings

# ULTRAVIOLET LIGHT BLEACHING OF CARBOXYLIC ACID ESTERS AND EPOXY COMPOUNDS

## BACKGROUND OF THE INVENTION

This invention relates to a process for bleaching organic carboxylic acid esters, and/or epoxy compounds.

More particularly, it relates to a process for bleaching organic carboxylic acid esters and/or epoxides employing the use of ultraviolet light irradiation and ketone.

Various carboxylic acid esters and epoxidized compounds have been widely used as plasticizers, stabilizers and surface active agents. Of particular significance are the epoxidized fatty acid esters which enjoy commercial acceptance as suitable plasticizers for various synthetic polymers, and particularly for vinyl chloride containing polymers, such as polyvinylchloride.

Generally, the carboxylic acid esters and epoxy compounds are discolored as initially obtained from the usual commercial methods of preparation. It is quite important, however, that these materials have as light a color as possible. This is so particularly when they are to be used as plasticizers, stabilizers, and surface active agents. Therefore, various processes have been developed in an attempt to produce materials having reduced color levels.

Included among such prior decolorization processes are treatment with caustic; and adsorption of color by either activated carbon, alumina, silica gel, or treated clays. Most of these prior decolorization techniques, however, do not effectively reduce the color of the material to provide products of acceptable light color, such as a color of less than 100 APHA (American Public Health Association Scale). In addition, some treated clays are highly acidic, and therefore, may cause decomposition of the epoxides resulting in loss of the product.

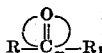
Of the above-mentioned methods, the most effective heretofore has been the caustic treatment. However, such a process suffers from the disadvantage in that it is necessary to wash the material with an aqueous solution after it has been refined with the caustic. In addition, this process presents the problem of separating two phases which are formed during the process. The separation in turn causes loss of some of the product.

In addition, there have been some suggestions in the prior art to decolorize certain specific esters employing ultraviolet light alone. For example, see U.S. Pats. No. 1,948,281 and 2,647,868. However, such methods have not achieved any appreciable commercial acceptance. The use of ultraviolet light alone although somewhat effective for certain esters is not very effective in bleaching various commercially important esters and epoxides. In particular, ultraviolet light alone as shown herein below is not very effective in bleaching certain epoxidized fatty acid esters. Also, it is even known that ultraviolet light actually darkens some esters. For example, see U.S. Pat. No. 1,179,414.

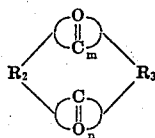
The process of the present invention overcomes these disadvantages and provides a bleaching process for carboxylic acid esters which is relatively inexpensive, quite efficient, and easily performed in a short time.

## BRIEF DESCRIPTION OF INVENTION

The process of this invention comprises the bleaching of an organic carboxylic acid ester and/or an epoxy compound by irradiating the carboxylic acid ester or epoxy compound with ultraviolet light in the presence of at least one ketone represented by the following structural formulas:



(I)



(II)

wherein R and R<sub>1</sub> each individually is either a nitroaryl group or an unsubstituted hydrocarbon group such as an alkyl group or an aryl group, or an aralkyl group or an alkaryl group, or a cycloalkyl group, each R<sub>2</sub> and R<sub>3</sub> individually is either a nitroarylene group or an unsubstituted hydrocarbon group such as an alkylene group, or an arylylene group or an aralkylene group, or an alkarylene group, or a cycloalkylene group, n is either 0 or 1, and m is either 1 or 2.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

The process of this invention is suitable for bleaching organic carboxylic acid esters or epoxy compounds, and particularly useful for decolorizing those esters or epoxides which are to be employed where light color is important. For example, it is important that plasticizers, surface active agents, and stabilizers are substantially free of color.

Some suitable acid esters include the mono-, di-, tri-, tetra-, penta-, and hexa-hydric alcohol esters of carboxylic acids.

Some suitable monohydric saturated aliphatic alcohols providing the alcohol moiety of the ester include methyl, ethyl, propyl, isopropyl, butyl, isobutyl, amyl, isoamyl, hexyl, heptyl, octyl, nonyl, and decyl alcohols.

Suitable dihydric alcohols include among others the lower glycols such as ethylene glycol, 1,2-propanediol, 1,3-propanediol, diethylmethylen glycol, trimethylene glycol, tetramethylene glycol, hexamethylene glycol, 1,3-butanediol, 1,4-butanediol, and 2,3-butanediol.

Suitable aliphatic alcohols which contain from 3 to 6 alcohol groups include glycerol, erythritol, pentaerythritol, dipentaerythritol, and hexitols, such as mannitol and sorbitol.

In addition benzenoid alcohols having less than 10 carbon atoms may be employed as the alcohol moiety in the acid esters of the present invention. Such alcohols include benzyl, phenyl, 2-phenylethyl, 1-phenylethyl, and nuclear methylated phenyl alcohols. Also cycloalkyl alcohols such as cyclohexanol can be employed as the alcohol moiety in the esters used herein.

The process of this invention is quite effective for bleaching fatty acid esters, polyesters, and most effective for bleaching epoxidized fatty acid esters.

Generally the fatty acid esters are esters of fatty acids having eight to 22 carbon atoms. Of particular importance are the triglycerides such as the animal, vegetable and marine oils, and the corresponding epoxidized oils.

Some suitable fatty acids include caprylic, pelargonic, lauric, myristic, palmitic, stearic, behenic, oleic, linoleic, linolenic, ricinoleic, and erucic acids.

Examples of some suitable fatty acid esters are tallow, soybean oil, linseed oil, tall oil fatty acid esters, safflower oil, perilla oil, sperm oil, menhaden oil, sunflower oil, cottonseed oil, and the corresponding epoxidized fatty acid esters.

Some examples of other suitable carboxylic acid esters are the various esters of phthalic acid and of adipic acid which are known plasticizers, such as dibutyl phthalate, dihexyl phthalate, dioctyl phthalate, didecyl phthalate, dibutyl adipate, dihexyl adipate, dioctyl adipate, and didecyl adipate.

The polyesters which can be bleached by the present process include the well known polycondensation products of polybasic acids and polyhydric alcohols. Numerous polyesters are commercially available and are adequately described in the literature including various U.S. patents. For example, a discussion of a large number of polyesters can be found in the book "Polyesters and Their Applications" by J. Bjorksten, H. Tovey, B. Harker and J. Henning, Reinhold Publishing Corporation, New York. The term "organic carboxylic acid esters" as used herein is understood to include polyesters.

Examples of some suitable epoxy compounds other than the epoxidized fatty acid esters include the alkylene oxides such as the butylene oxides. Usually the alkylene oxides to be employed in the process of this invention have up to about 20 carbon atoms and most often from about four to about 20 carbon atoms.

The preferred compounds are the epoxidized fatty acid esters of which epoxidized soybean oil and epoxidized tall oil esters are the most preferred. The epoxidized fatty oil esters generally have an oxirane content of about 3.5 to 9.5 percent and an iodine value less than 4.

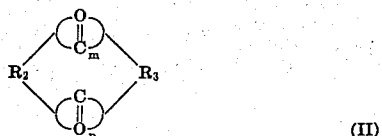
These epoxidized fatty acid esters which are bleached according to the present invention are commercially available and are readily obtainable by known methods fully described in numerous U.S. and foreign patents. For example, see U.S. Pats. Nos. 2,458,484 and 2,569,502. Of particular interest are the epoxidized compounds obtained by the reaction of the corresponding ethylenically unsaturated material with a strong oxidizing agent such as peracetic acid or hydrogen peroxide in an acid medium for upwards to 15 hours. In such a process the unsaturated material is substituted at the site of unsaturation with an oxirane oxygen.

These epoxidized materials as obtained from such a process are discolored and should be bleached if they are to be employed as plasticizers, stabilizers, and/or surface active agents. For example, an epoxidized ester such as epoxidized soybean oil may contain the following impurities which may contribute to the color of the epoxidized fatty acid ester:

1. phospholipides such as lecithin, cephalin, and sphingomyelin;
2. sterols such as cholesterol, stigmasterol, and ergosterol;
3. tocopherols;
4. lipochromes such as l-gossypol;
5. carotenoids (polyene pigments) such as lycopene, gamma carotene, beta carotene, alpha carotene, and zanthophylls; and
6. chlorophyll.

Although these above materials may initially be present in the epoxidized oil in merely trace amounts or even present in quantities that are not measurable, their discolorization effect can be quite noticeable. Accordingly, even a slight decrease in the quantity of the impurities over the prior art can have a tremendous effect upon the usefulness of the compound in large scale commercial applications. Also since the decoloring impurities can be present in such small quantities, their removal from the materials of the present invention is quite difficult.

The ketones to be employed according to the process of this invention are represented by the following structural formulas:



wherein R, R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, n and m have the same meanings as previously set forth. Of course, mixtures of these ketones can likewise be employed. R, R<sub>1</sub>, R<sub>2</sub>, and R<sub>3</sub> generally contain from one to 22 carbon atoms, and preferably from one to 14 carbon atoms. The ketones employed in the process of this invention are free of non-benzenoid unsaturation.

The most preferred ketones to be employed in the process of this invention are benzophenone, acetophenone, and acetone.

Examples of other useful ketones include methyl ethyl ketone, methyl isobutyl ketone, amylethyl ketone, cyclopropyl methyl ketone, cyclopropyl phenyl ketone, dicyclopropyl ketone, di-n-hexyl ketone, ortho-methyl acetophenone, anthraquinone, fluorenone, benzil, diacetyl, phenanthraquinone, 2,4,7 trinitrofluorenone, and 2,7-dinitrofluorenone. Of course, mixtures of ketones can be employed when desired.

Usually the ketone is employed in amounts ranging from about 0.005 to about 0.5 percent by weight based upon the

weight of the material being bleached. Of course, these amounts can vary somewhat depending upon the particular material being bleached and upon the particular ketone employed. Amounts of the ketone in excess of 0.5 percent by weight based on the epoxidized acid ester generally should not be employed since some materials such as the tall oil esters darkened somewhat at such levels. The preferred quantities of ketone range from about 0.01 to about 0.30 percent by weight based on the material being bleached, with the most preferred quantity being about 0.1 percent by weight.

The ultraviolet light to be employed in the process of this invention can be supplied by any convenient source of ultraviolet radiation. For example, a light source that emits photoenergy of wavelengths distributed throughout the range of from about 2,000 angstroms to about 4,000 angstroms can be employed. Preferably, the wavelength of light employed is between 2,500 and 3,500 angstroms. For best results, the wavelength of light should approximate that wavelength which represents the maximum absorption by the ketone being employed.

Some examples of light sources which can be employed in the process of this invention include those lamps which operate on the principle of either a zinc, cadmium, thallium, gallium, indium, carbon, mercury, zirconium, hydrogen, deuterium, xenon, or helium arc. Another possible source of radiant energy is direct sunlight since the radiation of the sun contains ultraviolet light. Suitable lamps to be used in carrying out the present invention include those commercially available high-pressure mercury arc lamps having a total power capacity ranging from about 50 watts to about 10,000 watts and generally from about 100 watts to about 600 watts. The preferred lamps though are the low-pressure mercury lamps having a total power capacity ranging from about 0.5 watts to about 50 watts. These lamps emit monochromatic light generally in wavelengths of about 2537 angstroms and in wavelengths of 3,000 angstroms and 3,550 angstroms with the addition of suitable phosphors. It is most convenient to employ ordinary fluorescent lamps which emit light of a wavelength of about 3,500 angstroms.

A quite suitable apparatus used to carry out the process of this invention is a Rayonet photochemical reactor. Also it may be desirable to form thin films of the material to be bleached and then expose the thin films to the action of the ultraviolet light.

The bleaching process of this invention can be carried out over a wide temperature range. For example, the reaction can be carried out at temperatures ranging from about 20° to about 122° C. Atmospheric pressure is most conveniently employed in carrying out the process of this invention. However, higher or lower pressures can be used when desired.

The bleaching process of this invention has generally been carried out in about one-half hour to about 4 hours. Generally, the time of bleaching will vary between about 1 hour and about 2 1/2 hours.

Of course, the time will be somewhat dependent upon the materials being bleached, the specific ketone, the amount of ketone, and the degree of bleaching desired; also the time may vary according to the particular configuration of the reactor being used. For instance, the bleaching time for a process wherein thin films of the material to be bleached are formed and then the films are exposed to the action of the ultraviolet light may be shorter than when using a Rayonet photochemical reactor.

In order that the invention may be better understood, the following examples are set forth wherein the amounts are by weight unless the contrary is stated:

#### EXAMPLE 1

100 parts of epoxidized soybean oil having an oxirane content of 6.9 percent, an acid value of 0.5, an iodine value of 2.3, and a color of 140 APHA and containing 0.1% by weight of benzophenone are placed in the center of a Rayonet

photochemical reactor containing 16 fluorescent lamps emitting black light at a wavelength of 3,500 angstroms and having a total power of 24 watts. The composition is continuously agitated with a magnetic stirrer. Upon irradiation with the ultraviolet light at a temperature of about 38° C for a period of one-half hour, the sample is bleached to a color of 95 APHA and to a color of 80 APHA in 2½ hours.

#### EXAMPLE 2

100 parts of the same epoxidized soybean oil as used in Example 1 and containing 0.1 percent by weight of acetophenone are placed in the center of a Rayonet photochemical reactor containing 16 fluorescent lamps emitting black light at a wavelength of 3,500 angstroms and having total power of 24 watts. The composition is continuously agitated with a magnetic stirrer. Upon irradiation with the ultraviolet light at a temperature of about 38° C for a period of 3 hours, the sample is bleached to a color of 60 APHA, and to a color of 55 APHA after 6 hours.

#### EXAMPLE 3

100 parts of the same epoxidized soybean oil as used in Example 1 and containing 0.5 percent by weight of acetone are placed in the center of a Rayonet photochemical reactor containing 16 fluorescent lamps emitting black light at a wavelength of 3,500 angstroms and having a total power of 24 watts. The composition is continuously agitated with a magnetic stirrer. Upon irradiation with the ultraviolet light at a temperature of about 38° C for a period of 3 hours, the sample is bleached to a color of 95 APHA. Better results are obtainable with a shorter wavelength of light for acetone.

#### EXAMPLE 4

100 parts of the same epoxidized soybean oil as used in Example 1 but without any ketone are placed in the center of a Rayonet photochemical reactor containing 16 fluorescent lamps emitting black light at a wavelength of 3,500 angstroms and having a total power of 24 watts. The composition is continuously agitated with a magnetic stirrer. Upon irradiation with the ultraviolet light at a temperature of about 38° C for a period of 6½ hours, the sample has a color of 130 APHA.

#### EXAMPLE 5

100 parts of epoxidized soybean oil having an oxirane content of 6.88 percent, an acid value of 0.4, an iodine value of 2.7, and a color of 105 APHA, without any ketone are placed in the center of a Rayonet photochemical reactor containing 16 fluorescent lamps emitting black light at a wavelength of 3,500 angstroms and having a total power of 24 watts. The composition is continuously agitated with a magnetic stirrer. Upon irradiation with the ultraviolet light at a temperature of about 38° C, for a period of 1½ hours, the sample still has a color of 105 APHA and even after hours of irradiation, the color of the oil is 105 APHA.

#### EXAMPLE 6

100 parts of the same epoxidized soybean oil as used in Example 5 and containing 0.1 percent by weight of acetophenone are placed in the center of a Rayonet photochemical reactor containing 16 fluorescent lamps emitting black light at a wavelength of 3,500 angstroms and having a total power of 24 watts. The composition is continuously agitated with a magnetic stirrer. Upon irradiation with the ultraviolet light at a temperature of about 38° C for a period of 1½ hours, the sample is bleached to a color of 45 APHA.

#### EXAMPLE 7

100 parts of an extracted oil from a filter cake containing an epoxidized soybean oil having a color of 11–12 Gardner and containing 0.1 percent by weight of benzophenone are placed

in the center of a Rayonet photochemical reactor containing 16 fluorescent lamps emitting black light at a wavelength of 3,500 angstroms and having a total power of 24 watts. The composition is continuously agitated with a magnetic stirrer. Upon irradiation with the ultraviolet light at a temperature of about 38° C for a period of 3 hours, the sample is bleached to a color of 8–9 [Gardner].

#### EXAMPLE 8

60 parts of epoxidized octyltallate having an oxirane content of 4.80 percent, an acid value of 0.2, an iodine value of 3.0 and a color of 120 APHA and containing 0.1 percent by weight of benzophenone are placed in the center of a Rayonet photochemical reactor containing 16 fluorescent lamps emitting black light at a wavelength of 3,500 angstroms and having a total power of 24 watts. The composition is continuously agitated with a magnetic stirrer. Upon irradiation with the ultraviolet light at a temperature of about 38° C for a period of 1½ hours, the sample is bleached to a color of 75 APHA.

#### EXAMPLE 9

100 parts of a polyester of adipic acid and propylene glycol, having an acid value of 2.50, a hydroxyl value of 10.6, a viscosity in stokes of 5.0, a molecular weight of about 720 and a color of 140 APHA and containing 0.1 percent by weight of benzophenone are placed in the center of a Rayonet photochemical reactor containing 16 fluorescent lamps emitting black light at a wavelength of 3500 angstroms and having a total power of 24 watts. The composition is continuously agitated with a magnetic stirrer. Upon irradiation with the ultraviolet light at a temperature of about 38° C for a period of 2 hours, the sample is bleached to a color of 105 APHA.

#### EXAMPLE 10

100 parts of epoxidized iso-octyl ester of soybean fatty acids having an oxirane content of 5.05 percent, an acid value of 1.7, an iodine value of 1.9, and a color of 125 APHA and containing 0.1 percent by weight of benzophenone are placed in the center of a Rayonet photochemical reactor containing 16 fluorescent lamps emitting black light at a wavelength of 3,500 angstroms and having a total power of 24 watts. The composition is continuously agitated with a magnetic stirrer. Upon irradiation with the ultraviolet light at a temperature of about 38° C for a period of 1½ hours, the sample is bleached to a color of 80 APHA.

#### EXAMPLE 11

100 parts of epoxidized soybean oil having an oxirane content of 6.70 percent, an acid value of 0.1, an iodine value of 1.9 and a color of 150 APHA and containing 0.1 percent by weight of benzophenone are placed in the center of a Rayonet photochemical reactor containing 16 fluorescent lamps emitting black light at a wavelength of 3,500 angstroms and having a total power of 24 watts. The composition is continuously agitated with a magnetic stirrer. Upon irradiation with the ultraviolet light at a temperature of about 38° C for a period of 1 hour, the sample is bleached to a color of 85 APHA.

The following examples demonstrate the ineffectiveness of various additives outside the scope of the intended ketones to promote the bleaching of the compounds of this invention.

#### EXAMPLE 12

100 parts of the same epoxidized soybean oil as used in Example 11 but containing 0.1 percent of 2,2'-dihydroxy-4-methoxy benzophenone are placed in the center of a Rayonet photochemical reactor containing 16 fluorescent lamps emitting black light at a wavelength of 3,500 angstroms and having a total power of 24 watts. The composition is continu-

ously agitated with a magnetic stirrer. Upon irradiation with the ultraviolet light at a temperature of about 38° C for a period of 1 hour, the sample still has a color of 150 APHA.

### EXAMPLE 13

100 parts of the same epoxidized soybean oil as used in Example 11 but containing 0.1 percent of 2-hydroxy-4-octyloxy benzophenone are placed in the center of a Rayonet photochemical reactor containing 16 fluorescent lamps emitting black light at a wavelength of 3500 angstroms and having a total power of 24 watts. The composition is continuously agitated with a magnetic stirrer. Upon irradiation with the ultraviolet light at a temperature of about 38° C for a period of 1 hour, the sample still has a color of 150 APHA.

The results of the examples are set forth below in tabular form.

| Ex. No. | Additive                                   | Time Hours | Original Color (APHA) | Final Color (APHA) |
|---------|--|------------|-----------------------|--------------------|
| 1       | 0.1% benzophenone                          | ½          | 140                   | 95                 |
| 2       | 0.1% acetophenone                          | 2½         | DO                    | 80                 |
|         |  | 3          | DO                    | 60                 |
| 3       | 0.5% acetone                               | 6          | DO                    | 55                 |
| 4       | None                                       | 3          | DO                    | 95                 |
| 5       | None                                       | 6%         | DO                    | 130                |
| 6       | 0.1% acetophenone                          | 8          | 105                   | 105                |
| 7       | 0.1% benzophenone                          | 1%         | DO                    | 45                 |
| 8       | DO   | 3          | *11-12                | *8-9               |
| 9       | DO   | 1%         | 120                   | 75                 |
| 10      | DO   | 2          | 140                   | 105                |
| 11      | DO   | 1½         | 125                   | 80                 |
| 12      | DO   | 1          | 150                   | 85                 |
| 13      | 0.1% 2,2'-dihydroxy-4-methoxy benzophenone | 1          | DO                    | 150                |
|         | 0.1% of 2-hydroxy-4-oxyloxy benzophenone   | 1          | DO                    | 150                |

\*color is Gardner color

The epoxidized materials bleached in the examples are obtained by epoxidizing the corresponding unsaturated material with hydrogen peroxide or peracetic acid for at least 10 hours in an acid medium according to known technology.

The APHA color is determined by a slightly modified method color comparison means with platinum-cobalt standards as originally established by the American Public Health Association and referred to by ASTM as "Color of Clear Liquids" (Platinum-Cobalt Scale) in Designation D1209-62. According to this method of color determination, a standard stock solution of platinum and cobalt which will be referred to hereinbelow as No. 500 Stock Solution is prepared as follows:

- 1.245 grams of potassium chloroplatinate ( $K_2PtCl_6$ ) Analytical Reagent and 1.000 grams of Cobalt Chloride ( $CoCl_2 \cdot 6H_2O$ ) American Chemical Society Grade are dissolved in distilled water in a 250 ml. volumetric flask;
- 25 ml. of HCl (Sp. Gr. 1.18) ACS Grade are then added;
- the solution is diluted to 250 ml. with distilled water;
- the 250 ml. solution from step (c) is then transferred to a 1,000 ml. volumetric flask;
- 75 ml. of HCl (Sp. Gr. 1.18) ACS Grade are then added; and
- the solution is then diluted to 1,000 ml. with distilled water which has first been passed through the 250 ml. volumetric flask in order to wash out any residual chemicals therein.

This 1,000 ml. solution has a color of 500 APHA. The 250 ml. solution from step (c) has a color of 2,000 APHA.

The color standards are then prepared from the No. 500 Stock Solution by diluting the required columns of No. 500 Stock Solution as set forth in the table below to 50 ml. with distilled water in 50 ml. tall form Nessler test tubes. Size No. 1 Kimble No. 45315A or B.

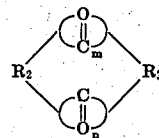
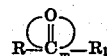
| No. 500 Stock Solution ML | Color Standard Number APHA |
|---------------------------|----------------------------|
| 0.5                       | 5                          |
| 1                         | 10                         |
| 1.5                       | 15                         |
| 2                         | 20                         |
| 2.5                       | 25                         |
| 3                         | 30                         |
| 3.5                       | 35                         |
| 4                         | 40                         |
| 5                         | 50                         |
| 6                         | 60                         |
| 7                         | 70                         |
| 10                        | 100                        |
| 15                        | 150                        |
| 20                        | 200                        |
| 25                        | 250                        |
| 30                        | 300                        |
| 35                        | 350                        |
| 40                        | 400                        |
| 45                        | 450                        |
| 50                        | 500                        |

ASTM color standards having the same color as above are prepared by doubling the amount of the No. 500 Stock Solution as in the table above, and diluted to 100 ml. in 100 ml. tall form Nessler test tubes, Size No. 2, Kimble No. 45315A or B with distilled water.

The color of a sample is determined by filling a standard 50 ml. Nessler tube of the type described above to the 50 ml. 50 and then comparing it with the nearest working standard by looking vertically downward through the tube upon a white surface placed in such a position that non-glaring daylight is reflected through the column of liquid. Of course at night, regular daylight lamps can be used.

What is claimed is:

- The process of bleaching a compound selected from the group consisting of organic carboxylic acid esters, epoxy compounds, and mixtures thereof, which comprises irradiating said compound with ultraviolet light in the presence of at least one member selected from the group consisting of ketones of the following structural formulas:



wherein R and  $R_1$  individually are selected from the group consisting of nitroaryl and unsubstituted hydrocarbons selected from the group consisting of alkyl, aryl, aralkyl, alkaryl, and cycloalkyl,  $R_2$  and  $R_3$  individually are selected from the group consisting of nitroarylene and unsubstituted hydrocarbons selected from the group consisting of alkylene, arylene, aralkylene, alkarylene, and cycloalkylene; n is either 0 or 1; and m is either 1 or 2, and mixtures of said ketones to improve the color of said compound.

2. The process of claim 1 wherein said compound is a fatty acid ester.

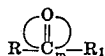
3. The process of claim 1 wherein said compound is an epoxidized fatty acid ester.

4. The process of claim 3 wherein said epoxidized fatty acid ester is an epoxidized fatty acid ester of fatty acid having eight to 22 carbon atoms.

5. The process of claim 1 wherein said compound is epoxidized soybean oil.

6. The process of claim 1 wherein said compound is epoxy octyltallate.

7. The process of claim 1 wherein said member has the structural formula:

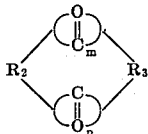


8. The process of claim 1 wherein said member has the structural formula:



wherein  $m$  is 1.

9. The process of claim 1 wherein said member has the structural formula:



10. The process of claim 1 wherein the ketone is selected from the group consisting of benzophenone, acetophenone and acetone.

11. The process of claim 1 wherein said ketone is benzophenone.

12. The process of claim 1 wherein said ketone is acetophenone.

13. The process of claim 1 wherein said ketone is acetone.

14. The process of claim 1 wherein said ketone is present in an amount between about 0.005 and about 0.5 percent by weight based upon the compound.

15. The process of claim 1 wherein said ketone is present in an amount of 0.1 percent by weight based upon the compound.

16. The process of claim 1 wherein said ultraviolet light has a wavelength between 3,000 and 3,500 angstroms.

17. The process of claim 1 wherein said irradiation is carried out at a temperature of about 38° C.

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