

UNITED STATES PATENT OFFICE

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PROCESS FOR BREAKING PETROLEUM EMULSIONS

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7 Claims. (Cl. 196-4)

This invention relates to the treatment of emulsions of mineral oil and water, such as petroleum emulsions, for the purpose of separating the oil from the water.

Petroleum emulsions are of the water-in-oil type, and comprise fine droplets of naturally-occurring waters or brines, dispersed in a more or less permanent state throughout the oil which constitutes the continuous phase of the emulsion. They are obtained from producing wells and from the bottom of oil storage tanks, and are commonly referred to as "cut oil", "roily oil", "emulsified oil", and "bottom settlings".

The object of our invention is to provide a novel and inexpensive process for separating emulsions of the character referred to into their component parts of oil and water or brine.

Briefly described, our process consists in subjecting a petroleum emulsion of the water-in-oil type to the action of a treating agent or demulsifying agent of the kind hereinafter described, thereby causing the emulsion to break down and separate into its component parts of oil and water or brine, when the emulsion is permitted to remain in a quiescent state after treatment, or is subjected to other equivalent separatory procedures.

The treating agent or demulsifying agent contemplated by our process consists of or comprises an amine of the kind hereinafter described. Said demulsifying agent may be in the form of the amine itself, or in the form of the amine base derived by contact with water, or in the form of a salt. The particular amine employed as the demulsifying agent in our process is characterized by the fact that it is derived from a fatty acid or fatty acid ester, such as a glyceride, in such a manner that the fatty acid radical or residue (the oxyacyl radical) is attached to the nitrogen atom of the amine through a carbon atom chain, which carbon atom chain is in turn alkyl, aralkyl, or alicyclic in nature. Said composition and the method of manufacturing the same will be subsequently described in detail.

As previously noted, the amines employed in the present process are derived from higher fatty acids or their esters. For sake of convenience, these materials will be referred to as fatty acids.

The fatty acids are derived from animal, vegetable, and marine sources and include such materials as palm oil, palm kernel oil, cocoanut oil, olive oil, peanut oil, castor oil, cottonseed oil, sesame oil, corn oil, soya bean oil, linseed oil, China-wood oil, rapeseed oil, tallow, lard, blown fat, herring oil, fish oil, menhaden oil, sperm

oil, etc. For sake of convenience, acids occurring in certain waxes, such as carnaubic acid, cerotic acid, lanopalmic acid, and lanoceric acid, will be considered as fatty acids.

The specific fatty acids present includes among others, oleic acid, stearic acid, linolic acid, linolenic acid, clupanodonic acid, ricinoleic acid, dihydroxystearic acid, etc.

The fatty acids or suitable derivatives thereof, for instance, the fatty acids themselves or the esters derived from monohydric or dihydric alcohols, or the naturally-occurring glycerides, may be reacted with selected tertiary hydroxyamines to give reagents of the kind employed in the present process for resolving oil field emulsions. Not only may the fatty acids and their esters be employed, but also suitable derivatives, such as the acyl chlorides, the anhydrides, or any suitable form that supplies the acyl radical of the fatty acid.

In order to clearly point out how the reagents employed in the present process are different from various other nitrogenous products, and particularly various related amines or amides, it may be well to indicate briefly certain reactions of fatty acids and amines. In the case of primary or secondary amines, the reactions may be indicated by the following:

(A) Salt formation

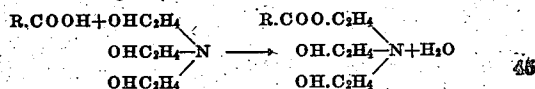


(B) Amide formation



(C) The third type of reaction involves the fatty acid in the form of a salt so as to produce amino fatty acids.

(D) Still another type of reaction involves fatty acids and a tertiary alkylolamine or its functional equivalent, such as a tertiary hydroxyalicyclic amine. Such reaction may be indicated in the following manner:



We have discovered that if various oils or fats or their functional equivalents of the kind previously described are reacted with hydroxy tertiary amines, one obtains materials of the kind characterized by the fact that the fatty acid radicals are present in the amine compound in an esterified form.

As to the production of amines employed in the present process, it is interesting to note that

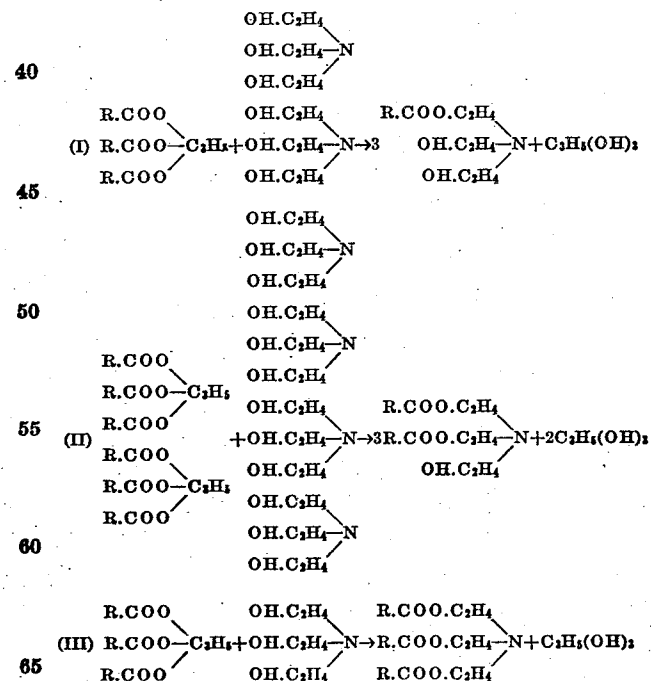
the products are well known compositions of matter and that the methods of producing the same are well known and do not require further elaboration, with the exception that the production of the materials from hydroxylated fatty acids, that is, ricinoleic acid, hydroxystearic acid, and the like, appears to yield different products dependent upon whether or not the ester is used on one hand or the fatty acid, for example, is used on the other. The reason for this different state of affairs in regard to the hydroxy fatty acids is that an attempt to produce the products from the fatty acids results in polymerization, which is not true when the esters are employed.

It is furthermore believed that the production of these materials in absence of the amine salts is apparently broadly new. Attention is directed to our copending applications, Ser. No. 180,992 and Ser. No. 180,993, both dated December 21, 1937, and our copending application, Ser. No. 191,964, dated February 23, 1938.

In view of the somewhat complicated nature of the demulsifying agents employed, it may be well to point out some of the general types of reactions which may be involved in their manufacture. For convenience, the fatty acid will be considered as $R.COOH$ and the fatty oil or fat or wax will be considered as a glyceride and indicated thus:



Purely as a matter of convenience, triethanolamine will be selected as the tertiary hydroxyamine for reaction with the selected oil, fat, fatty acid, or functional equivalent. The reactions taking place in varying proportions with the glyceride may be indicated in the following manner:



The manufacture of these compounds is relatively simple. The selected fatty oil and the selected hydroxy tertiary amine are mixed in suitable proportions and heated at some point above the boiling point of water, for instance, $110^\circ C.$, and at a point below the decomposition point of the amine or the fatty oil, for instance, $180^\circ C.$, for a suitable period of time, such as 2 to 8 hours. Mild agitation is employed. A catalyst such as

sodium oleate, sodium carbonate, caustic soda, etc., may be present in amounts of about one-half of 1% or less. It is noted that the fatty acids are employed in this instance in the form of an ester, to-wit, the glyceride, although as previously pointed out, other functional equivalents can be readily employed with equal facility. It is to be noted that the reactions above described do not take place to any appreciable extent if the fatty acid has been converted into the soap or salt. Such salts are not functional equivalents.

It is to be remembered that the reactions take place in any event under conditions which are substantially anhydrous. In other words, if water is formed in an esterification reaction, such as one involving one mole of stearic acid, and one mole of triethanolamine, it is driven off or eliminated immediately because the temperature of reaction is above the boiling point of water. Naturally under such circumstances there is no objection to passing a dry inert gas through the mixture to hasten esterification.

Four additional facts must be borne in mind in regard to these compounds. In the first place, these amines which are employed as demulsifying agents in the present process are not quaternary ammonium bases or salts thereof. The expression "quaternary ammonium" is properly conventionally applied to compounds in which all four hydrogen atoms of the ammonium radical NH_4 have been replaced by a hydrocarbon radical or oxyhydrocarbon radical, as, for example, in trimethyl phenyl ammonium hydroxide.

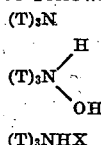
Secondly, an important characteristic which must be recognized is that these amine compounds are not amides. It has been previously

pointed out that an amide formation involves a product in which there is a direct linkage between the carboxylic carbon atom and the nitrogen atom in the amine. This is not the case in the compounds employed as demulsifying agents in the present process.

In the third place, it must be recognized that these compounds are derived only from basic tertiary amines. The word "basic" is employed to

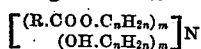
exclude amines having little or no basicity such as the ordinary aromatic amines or any amine having at least one aryl radical directly joined to the amino nitrogen atom. For this reason, these amine products which are herein contemplated as demulsifying agents and which necessarily are characterized by freedom from any aryl groups as such, cannot be derived from aryl amines. They are derived solely from alkyl, alicyclic, or aralkyl amines having at least one hydroxyl group present. It is true that in the aralkyl amines there is an aryl group present, but it is not directly attached to the nitrogen atom as in the case of aryl amines but in fact represents nothing more or less than a substituted alkylamine. For instance, we consider benzylamine as being the primary amine, phenmethylamine.

Finally, it must be recognized that these materials have not lost any basicity in the forms of the esterified amine and that they exhibit all the properties of a basic amine, that is, they combine with water to form a base presumably a substituted ammonium compound, but not a quaternary ammonium compound insofar that there is always one unsubstituted hydrogen atom of the ammonium radical present. They combine with various acids to form salts. For example, they may be combined with acetic acid, hydrochloric acid, lactic acid, chloracetic acid, nitric acid, butyric acid, phosphoric acid, oxalic acid, or any suitable organic or inorganic acid, to form salts. It is understood that the reference in the specification and appended claims to the amines includes the basic form and the acid salts as well as the amines themselves. The characteristic demulsifying properties are contributed by the amine, and it is immaterial whether they may be considered as being in any one of the three following forms:



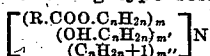
in which T represents the substituents of the amino hydrogen radicals of the parent ammonia from which all amines are hypothetically derived and X simply represents the acid radical of any acid employed.

In referring to the amines derived by reactions involving fatty oils and triethanolamine, it is to be noted that the products may be characterized by the following formula:



in which m is 1, 2, or 3, m' is 0, 1, or 2, with the proviso that $m+m'+m''=3$, and n denotes any small whole number, preferably less than 10, and in the case of triethanolamine, denotes the number 2.

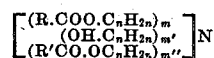
If instead of employing triethanolamine, ethyl diethanolamine, or a similar amine were employed, then the resulting products would be indicated by the following type formula:



in which m is 1 or 2, m' is 0 or 1, m'' is 1, with the proviso that $m+m'+m''=3$; and n has the same significance as above.

In event that diethylaminoethanol were employed, it is manifest that another variation of the above formula would appear. It is also possible

to obtain compounds from such materials as acetylated triethanolamine in which the acetyl radical has replaced one hydrogen atom of one of the hydroxy ethyl radicals. Acetic acid in this instance may be considered typical of the lower fatty acids which have less than 7 carbon atoms. If such monoacetylated triethanolamine were employed, the reaction product would be indicated by the following type formula:



in which m is 1 or 2, m' is 0 or 1, m'' is 1 or 2, and n has the same significance as above with the added proviso that $m+m'+m''$ must be equal to 3.

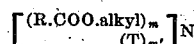
In the above formula $R'.CO$ indicates an acyl radical derived from a low molecular weight fatty acid having less than 7 carbon atoms. Attention is directed to the fact that the divalent aliphatic radical indicated by C_nH_{2n} may be a radical such as a C_2H_4 radical, C_3H_6 radical, C_4H_8 radical, C_5H_{10} radical, or it may be an alicyclic radical or an aralkyl radical, as will become obvious from the kind of amines subsequently enumerated. Furthermore, where the radical C_nH_{2n+1} , which is a typical alkyl radical, appears, it may be a methyl radical, ethyl radical, propyl radical, butyl radical, amyl radical, hexyl radical, octyl radical, etc. On the other hand, instead of being a monovalent alkyl radical, it may be a monovalent alicyclic radical such as a cyclohexyl radical, or it may be an aralkyl radical, such as a benzyl radical. In the claims appended hereto, it is understood that the expression "alkylol" includes the hydroxy hydrocarbon radicals whether derived from alkyl, alicyclic, or aralkyl radicals. It is furthermore understood in the hereto appended claims that the expression "hydroxy alkyl" includes hydroxy alicyclic as well as hydroxy aralkyl radicals, provided that in the latter the hydroxyl group is attached to the aliphatic side chain. Attention is also directed to the fact that the teritary amines involving the glyceryl radical $(C_3H_5OH)_2$ may substitute for the hydroxy alkyl radicals of the kind described. It is also understood that alkyl-oxy-alkyl radicals are the equivalent of an ordinary alkyl radical, insofar that they might appear in products such as the trihydroxy ethyl ether of triethanolamine which may be indicated by the following formula:



See other examples described in U. S. Patent No. 1,923,178, dated August 22, 1933, to Ulrich et al.

Such material would be the obvious functional equivalent of triethanolamine in reactions of the kind contemplated in the manufacture of the demulsifying agents employed in the present process.

The amine employed as a demulsifying agent in the present process might be indicated by the following formula:



in which m is 1, 2, or 3, m' is 0, 1, or 2, with the proviso that $m+m'=3$, T is an alkyl radical or a radical of the type $(R'.CO.O.alkyl)$ or a hydroxy alkyl radical, and $R'.CO.O$ represents an acid radical having less than 7 carbon atoms. The expression "alkyl" is used in the broad sense previously specified, and it is also to be repeated that the amine may be in the form of the base or in the form of a salt.

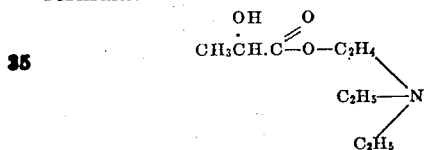
Suitable bases which may be reacted with fatty oils or completely esterified fatty oils or esterified fatty acids to produce the demulsifying agent contemplated in the present process include:

5 triethanolamine, diethanolalkylamines, such as diethanol ethylamine, diethanol propylamine, etc.; tertiary glyceryl amines such as monoglyceryl diethylamine, monoglyceryl dipropylamine, diglyceryl propylamine, triglycerylamine, etc.

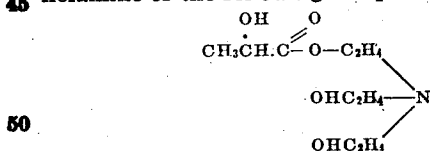
10 Other examples include diethanol methylamine, tripropanolamine, dipropanol methylamine, cyclohexanol diethanolamine, dicyclohexanol ethanolamine, cyclohexyl diethanolamine, dicyclohexyl ethanolamine, dicyclohexanol ethylamine,

15 benzyl diethanolamine, dibenzylethanolamine, benzyl dipropanolamine, tripentanolamine, trihexanolamine, ethyl hexyl ethanolamine, octadecyl diethanolamine, polyethanolamine, etc.

In indicating the various hydroxylated tertiary amines of the non-aryl type which may be employed to produce the amine contemplated as the demulsifying agent of the present process, it is desirable to indicate that amines of the type where a hydroxy acyl radical replaces a hydrogen atom of the hydroxyl radical of the hydroxy tertiary amine, are not included within the broad class of hydroxy tertiary amines unless there is another hydroxyl radical attached to the usual alkyl radical. For instance, if diethyl amino ethanol is treated with lactic acid so as to form lactyl ethanol diethylamine of the following formula:



40 then it is understood that such materials would not represent a hydroxy tertiary amine within the meaning or scope as herein employed. If, on the other hand, triethanolamine were treated with lactic acid so as to give monolactyl triethanolamine of the following composition:



50 then such compound would be included due to the presence of one or more hydroxyl radicals attached to the alkyl radicals.

Example I

Castor oil (triricinolein) is employed. For sake of convenience, its molecular weight is considered as being 925. Commercial triethanolamine and castor oil in the proportion of one mole of castor oil to three moles of triethanolamine are heated to a temperature between 150° and 180° C. for about 2 hours. Mild agitation is employed. The reaction product so produced may be used as such or may be converted into the acetate by the addition of the maximum amount of glacial acetic acid which can be added without causing acidity to methyl orange indicator. Generally speaking, this will require about three moles of glacial acetic acid which can be added without causing acidity to methyl orange indicator.

Example II

75 Triglycerylamine (tridihydroxy propylamine) is substituted for triethanolamine in Example I.

Example III

Diamyl monoglycerolamine (1-di-amyl amino propane 2,3, diol) is substituted for triethanolamine in Example I.

Example IV

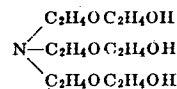
Dicyclo hexylamine is reacted with glycerol monochlorhydrin to give monoglyceryl dicyclohexylamine. This product is substituted for triethanolamine in Example I.

Example V

Dibenzylamine is reacted with glycerol monochlorhydrin to produce monoglyceryl dibenzylamine. This product is substituted for triethanolamine in Example I.

Example VI

Polyethanolamine:



is substituted for triethanolamine in Example I.

Example VII

Ethyl hydroxy stearate is reacted in the previous manner with the various amines above enumerated in the various examples. In this case one mole of ethyl dihydroxy stearate is reacted with one mole of the tertiary hydroxyamine.

Example VIII

Methyl hydroxy stearate is employed to replace ethyl dihydroxy stearate in the examples indicated under Example VII above.

We desire to emphasize that the products obtained in the above examples may be used in the form of the amine by direct contact with an emulsion without contact with water. They may be contacted with water, that is, used in the form of a solution so as to produce in a greater or lesser degree the amine base. Furthermore, any of the products above described may be combined with suitable acid. Acetic acid may be employed. Hydrochloric acid is particularly desirable. In some instances, acids such as oleic acid or naphthenic acid may be employed to give a suitable salt.

In examining the method of manufacture of these compounds as previously described, it is apparent that certain by-products appear such as glycerine, mono- or di-glycerides, etc. From a practical standpoint it is unnecessary to separate these cogeneric materials, though it would be possible to do so by conventional processes. It is quite possible that these materials which appear as a part of the reaction mass contribute to a greater or lesser degree to the demulsifying power of the amine body. It may be that some of these materials which appear in the reaction mass cannot be completely identified as to their form. For instance, it is at once possible to see that condensation products might be formed under proper conditions between amines of the kind contemplated as demulsifying agents in the present process and either glycerol or triethanolamine, by virtue of an ether linkage. In view of this fact, in the appended claims the demulsifying agent will not only be described in terms of the chemical structure of the amine, but also in terms of the method of manufacture. The purpose of the claims, which are characterized by reference to the method of manufacture, is to

specifically include the general reaction mass produced in the manufacture of the amine bodies.

It is well known that fatty acids can be modified by addition or substitution, so that the resultant products are still monobasic. For instance, oleic acid can be converted into oleic acid dichloride. Stearic acid can be converted into dichlorostearic acid, etc. In these instances the modified fatty acid still acts as the functional equivalent of the fatty acid for purposes such as the reactions indicated in describing the manufacture of the demulsifying agents used in the present invention. It is to be noted that the introduction of a chlorine atom, bromine atom, iodine atom, or an alkyl radical, for example, does not result in converting a monobasic acid, i. e., the ordinary fatty acid, into a polybasic acid. It is not intended that functional modification shall include such derivatives as obtained by treating ricinoleic acid, for example, with sulfuric acid, phosphoric acid, boric acid, phthalic acid, oxalic acid, maleic acid, etc., all of which results in the introduction of a radical having an ionizable hydrogen atom; or in other words, converting the monobasic fatty acid into a polybasic acid, in which case all the acid radicals may be carboxy in nature or they may be mixed in nature, i. e., both sulfo and carboxy.

One should not lose sight of the fact, however, that the present invention is concerned particularly with the employment of certain chemical compounds of definitely stated composition which are present in significant or predominant amounts in the mixtures obtained by the reactions described. Needless to say, the employment of the selected demulsifying agents in the art of breaking crude oil emulsions is not limited to any particular method of manufacture except in the appended claims, in which specific reference is made to manufacturing procedure.

Attention is directed to the fact that the word "amidification" has been applied to the reaction involving the replacement of an amino hydrogen atom by an acyl radical without conventional limitation to a reaction involving ammonia. The replacement of the amino hydrogen atom of a primary amine or a secondary amine by an acyl radical has been considered as being amidification rather than the formation of a substituted amide or the formation of an imide or substituted imide. Such obvious departure from conventional nomenclature has been for purposes of simplicity and to show the similarity between certain reactions.

Conventional demulsifying agents employed in the treatment of oil field emulsions are used as such, or after dilution with any suitable solvent, such as water, petroleum hydrocarbons, such as gasoline, kerosene, stove oil, a coal tar product, such as benzene, toluene, xylene, tar acid oil, cresol, anthracene oil, etc. Alcohols, particularly aliphatic alcohols, such as methyl alcohol, ethyl alcohol, denatured alcohol, propyl alcohol, butyl alcohol, hexyl alcohol, octyl alcohol, etc., may be employed as diluents. Miscellaneous solvents, such as pine oil, carbon tetrachloride, sulfur dioxide extract obtained in the refining of petroleum, etc., may be employed as diluents. Similarly, the material or materials employed as the demulsifying agent of our process may be admixed with one or more of the solvents customarily used in connection with conventional demulsifying agents. Moreover, said material or materials may be used alone or in admixture with other suitable well known classes of demulsifying agents.

It is well known that conventional demulsifying agents may be used in a water-soluble form, or in an oil-soluble form, or in a form exhibiting both oil and water solubility. Sometimes they may be used in a form which exhibits relatively limited water solubility and relatively limited oil solubility. However, since such reagents are sometimes used in a ratio of 1 to 10,000 or 1 to 20,000, or even 1 to 30,000, such an apparent insolubility in oil and water is not significant, because said reagents undoubtedly have solubility within the concentration employed. This same fact is true in regard to the material or materials employed as the demulsifying agent of our process.

We desire to point out that the superiority of the reagent or demulsifying agent contemplated in our process is based upon its ability to treat certain emulsions more advantageously and at a somewhat lower cost than is possible with other available demulsifiers, or conventional mixtures thereof. It is believed that the particular demulsifying agent or treating agent herein described will find comparatively limited application, so far as the majority of oil field emulsions are concerned; but we have found that such a demulsifying agent has commercial value, as it will economically break or resolve oil field emulsions in a number of cases which cannot be treated as easily or at so low a cost with the demulsifying agents heretofore available.

In practicing our process, a treating agent or demulsifying agent of the kind above described is brought into contact with or caused to act upon the emulsion to be treated, in any of the various ways or by any of the various apparatus now generally used to resolve or break petroleum emulsions with a chemical reagent, the above procedure being used either alone or in combination with other demulsifying procedure, such as the electrical dehydration process.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

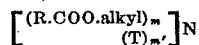
1. A process for breaking petroleum emulsions of the water-in-oil type, characterized by subjecting the emulsion to the action of a demulsifying agent comprising a composition of matter derived by reaction, under substantially anhydrous conditions, between a chemical compound containing an acyl radical derived from a fatty acid and a non-aryl tertiary hydroxy amine within the molal ratio of 1:1 and 1:3, at a temperature above the boiling point of water and below the point of decomposition; said reaction being conducted in a manner to yield a substantial quantity of basic material in which the fatty acid radical is attached to the basic nitrogen atom through a carbon atom chain; with the added proviso that in said basic material the ratio of said acid radical to the amino nitrogen atom shall be at least 1:1 and not more than 3:1; and said basic material being further characterized by absence of amide and polyamino radicals.

2. A process for breaking petroleum emulsions of the water-in-oil type, characterized by subjecting the emulsion to the action of a demulsifying agent comprising a composition of matter derived by reaction, under substantially anhydrous conditions, between a fatty acid glyceride and a non-aryl tertiary hydroxy amine within the molal ratio of 1:1 and 1:3, at a temperature above the boiling point of water and below the point of decomposition; said reaction being conducted in a manner to yield a substantial quantity of

basic material in which the fatty acid radical is attached to the basic nitrogen atom through a carbon atom chain; with the added proviso that in said basic material the ratio of said acid radical to the amino nitrogen atom shall be at least 1:1 and not more than 3:1; and said basic material being further characterized by absence of amide and polyamino radicals.

3. A process for breaking petroleum emulsions of the water-in-oil type, characterized by subjecting the emulsion to the action of a demulsifying agent comprising a composition of matter derived by reaction, under substantially anhydrous conditions, between a fatty acid glyceride and triethanolamine, within the molal ratio of 1:1 and 1:3, at a temperature above the boiling point of water and below the point of decomposition; said reaction being conducted in a manner to yield a substantial quantity of basic material in which the fatty acid radical is attached to the basic nitrogen atom through a carbon atom chain; with the added proviso that in said basic material the ratio of said acid radical to the amino nitrogen atom shall be at least 1:1 and not more than 3:1; and said basic material being further characterized by absence of amide and polyamino radicals.

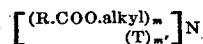
4. A process for breaking petroleum emulsions of the water-in-oil type, characterized by subjecting the emulsion to the action of a demulsifying agent comprising a chemical compound of the type indicated by the formula:



- in which m is 1, 2, or 3, m' is 0, 1, or 2, with the proviso that $m+m'=3$, T is selected from the class consisting of alkyl radicals, or radicals of the type $(R'.COO.alkyl)$ and hydroxy alkyl radicals,

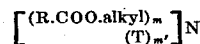
and $R.COO$ represents a fatty acid radical, and $R'.COO$ is an acid radical having less than 7 carbon atoms.

5. A process for breaking petroleum emulsions of the water-in-oil type, characterized by subjecting the emulsions to the action of a demulsifying agent comprising a chemical compound of the type indicated by the formula:



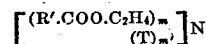
in which m is 1 or 2, and m' is 1 or 2, with the proviso that $m+m'=3$, T is a hydroxy alkyl radical, and $R.COO$ is a fatty acid radical.

6. A process for breaking petroleum emulsions of the water-in-oil type, characterized by subjecting the emulsion to the action of a demulsifying agent comprising a chemical compound of the type indicated by the formula:



in which m is 1, or 2, and m' is 1, or 2, with the proviso that $m+m'=3$, T is a hydroxy ethyl radical, and $R.COO$ is a fatty acid radical.

7. A process for breaking petroleum emulsions of the water-in-oil type, characterized by subjecting the emulsion to the action of a demulsifying agent comprising a chemical compound of the type indicated by the formula:



in which m is 1 or 2, and m' is 1 or 2, with the proviso that $m+m'=3$, T is a hydroxy ethyl radical, and $R'.COO$ is a ricinoleic acid radical.

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