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MINERAL OIL COMPOSITION

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16 Claims. (Cl. 252—51.5)

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This invention has to do in a general way with mineral oil compositions and is more particularly related to compositions comprised of mineral oil and a minor proportion of an added ingredient which will improve the oil in one or more important respects.

It is well known to those familiar with the art that mineral oil fractions refined for their various uses are in and of themselves usually deficient in one or more respects so that their practical utility is limited even in the particular field for which they have been refined. For example, mineral oil fractions refined for use as lubricants have a tendency to oxidize under conditions of use, with the formation of sludge or acidic oxidation products; also, the lighter fractions such as gasoline and kerosene tend to oxidize with the formation of color bodies, gum, etc. In order to prevent the formation of these products and thereby extend the useful life of the oil fraction, it is common practice to blend with such oil fraction an additive ingredient which will inhibit oxidation, such ingredients being known to the trade as oxidation inhibitors, antioxidants, sludge inhibitors, gum inhibitors, etc.

It is also the practice to add other ingredients to mineral oil fractions for the purpose of improving "oiliness" characteristics and the wear-reducing action of such mineral oils when they are used as lubricants, particularly when the oils are used for the purpose of lubricating metal surfaces which are engaged under extremely high pressures and at high rubbing speeds.

Various other ingredients have been developed for the purpose of depressing the pour point of mineral oil fractions which have been refined for use as lubricants. Most refining treatments provide oils containing a small amount of wax which, without the added ingredient, would tend to crystallize at temperatures which render the oil impracticable for use under low temperature conditions. Additive agents have also been developed for improving the viscosity index of lubricating oil fractions. In the case of internal combustion engines, particularly those operating with high cylinder pressures, there is a decided tendency for the ordinary lubricating oil fractions to form carbonaceous deposits which cause the piston rings to become stuck in their slots and which fill the slots in the oil ring or rings, thus ma-

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terially reducing the efficiency of the engine. Ingredients have been developed which, when added to the oil, will reduce this natural tendency of the oil to form deposits which interfere with the function of the piston rings.

It has also been discovered that certain types of recently-developed hard metal alloys, such as cadmium-silver alloy bearings, are attacked by ingredients in certain types of oils, particularly oils of high viscosity index obtained by various methods of solvent-refining. This corrosive action on such alloys has led to the development of corrosion-inhibitors which may be used in solvent-refined oils to protect such bearing metals against this corrosive action.

In the lighter mineral oil fractions, such as those used for fuel purposes, particularly in internal combustion engines, it has been found that the combustion characteristics of the fuel may be controlled and improved by adding minor proportions of various improving agents thereto.

The various ingredients which have been developed for use in mineral oil fractions to improve such fractions in the several characteristics enumerated above are largely specific to their particular applications. Therefore, it has been the practice to add a separate ingredient for each of the improvements which is to be effected.

The present invention is predicated upon the discovery of a group or class of oil-soluble reaction products or compounds which, when added to mineral oil fractions in minor proportions, will improve the oil fractions in several respects.

The novel addition agents contemplated by this invention as multi-functional improvers for mineral oils are the condensation products of an aldehyde, a polyamine in which each amino group is characterized by the presence of at least one hydrogen atom, and a hydroxyaromatic compound. Preferred reaction products are those obtained by condensing about one molar equivalent of an aldehyde with at least one-quarter molar equivalent of a polyamine of the aforementioned character and a molar equivalent of a hydroxyaromatic compound. The condensation is preferably carried out in the presence of a suitable solvent.

Aldehydes contemplated by the present invention are the aliphatic aldehydes, typified by formaldehyde (such as trioxymethylene), acetal-

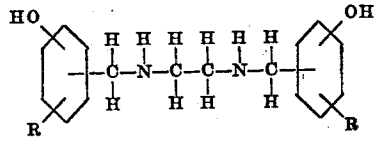
dehyde, and aldol (β-hydroxy butyraldehyde); aromatic aldehydes, representative of which is benzaldehyde; heterocyclic aldehydes, such as furfural; etc. The aldehyde may contain a substituent group such as hydroxyl, halogen, nitro and the like; in short, any substituent which does not take a major part in the reaction. Preference, however, is given to the aliphatic aldehydes, formaldehyde being particularly preferred.

The polyamines contemplated herein are those in which each amino group is characterized by the presence of at least one hydrogen atom. Such polyamines may contain only primary amino groups, only secondary amino groups, or both primary and secondary groups. Typical polyamines are the aliphatic homologs, ethylene diamine, propylene diamine, polyalkene polyamines (e. g., diethylene triamine, triethylene tetramine); the aromatic homologs, o-, m- and p-phenylene diamine, diamino naphthalenes, etc. Of this class of amines, preference is given to the diamines in which two primary amino groups are attached to adjacent carbon atoms, and particular preference is accorded ethylene diamine.

Representative hydroxyaromatic compounds contemplated by the present invention are phenol, resorcinol, hydroquinone, catechol, cresol, xylenol, hydroxydiphenyl, benzylphenol, phenylethylphenol, phenol resins, methylhydroxydiphenyl, guiacol, alpha and beta naphthol, alpha and beta methylnaphthol, tolylnaphthol, xylylnaphthol, benzylnaphthol, anthranol, phenylmethylnaphthol, phenanthrol, monomethyl ether of catechol, phenoxyphenol, chlorphenol, and the like. Preference in general is to the monohydroxy phenols otherwise unsubstituted, particular preference being given to phenol and alpha and beta naphthol.

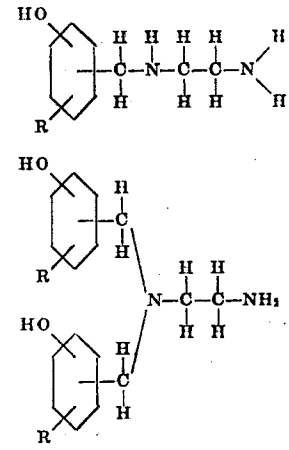
As indicated hereinabove, the hydroxyaromatic compound may contain one or more alkyl substituents such as short-chain groups, typified by methyl, ethyl, amyl, etc.; or long-chain, relatively-high-molecular-weight hydrocarbon groups having at least twenty carbon atoms, typified by alkyl groups derived from petroleum wax, which is a predominantly straight-chain aliphatic hydrocarbon of at least twenty carbon atoms. It will be obvious to those skilled in the art that the maximum number of alkyl groups is limited by the number of valences on the aromatic nucleus available for substitution. Naturally, the maximum number of such groups which can be attached to a single aromatic nucleus will vary as the nucleus is mono- or polycyclic and as the nucleus is otherwise substituted, with such groups as carboxy, nitro, amino, halogen and the like.

The present application has been purposely directed to condensation products of the aforesaid reactants for, as yet, the theory of reaction is not fully understood. Some evidence is available—for example, quantitative analysis of the reaction product—to point to the presence of a major quantity of one compound. For instance, when typical reactants, such as an alkyl-substituted phenol, formaldehyde and ethylene diamine, are reacted as hereinafter described, analysis indicates that the predominant product is:

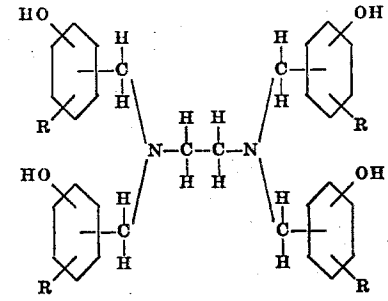


wherein R is an alkyl group.

Probably also present in the condensation product are compounds of the following type:



and



The foregoing is for illustrative purposes only and is not to be construed as limiting the present invention to a theory of reaction because the present invention is directed primarily to condensation products obtained by inter-reaction of the reactants described herein as multifunctional improving agents for lubricating oils and the like.

In preparing the condensation products contemplated herein, the reactants may be added to each other in any order. A typical procedure involves adding the aldehyde to an alcohol solution of the hydroxyaromatic compound and the amine. The reaction may also be carried out in the presence of other diluents or solvents such, for example, as tetrachlorethane, chlorbenzene, mineral oil, etc. In the event that mineral oil is used as a diluent, the mineral oil may be retained, rather than separated from the reaction product, thereby providing a mineral oil concentrate.

The reaction temperature may be varied considerably, depending upon the time of reaction, the specific reactants used, etc. For example, the reaction can be carried out at room temperature over a relatively long period of time or at the reflux temperature of the solvent over a comparatively short period. By way of illustration, the reactants, in quantities such as shown in the following examples, may be thoroughly mixed at room temperature for several hours and the reaction completed at the reflux temperature of the solvent for an additional period of several hours.

The reaction product may be water washed to assure complete removal of any unreacted amine and this is recommended when the amine is high boiling. When an alcohol is used as a diluent in the reaction, it is distilled from the reaction mixture, thereby also removing any unreacted amine and water of reaction or water added with the reactants (Formalin, for example, is generally used in a 37% aqueous solution).

As stated above, the general procedure for preparing the contemplated condensation products involves the interreaction of a hydroxyaromatic compound, an aliphatic aldehyde, and a polyamine wherein the amino groups have at least one free hydrogen.

A typical, and also preferred, alkyl-substituted hydroxyaromatic compound which may be used is a wax-substituted phenol, "wax-phenol." The term "wax" as used herein designates petroleum wax or aliphatic hydrocarbons or hydrocarbon groups of the type which characterize petroleum wax. These so-called "wax" substituents may be obtained by alkylation of the phenol or hydroxy-aromatic hydrocarbon with a relatively-high-molecular weight aliphatic hydrocarbon or mixture of such hydrocarbons (such as petroleum wax) by any suitable alkylation procedure such, for example, as by a Friedel-Crafts condensation of chlorinated petroleum wax with phenol.

Details of a preferred procedure for making the condensation products of this invention where the aforesaid wax-phenol is employed as the alkyl-substituted hydroxyaromatic compound may be obtained from the following examples:

EXAMPLE I

A. Alkylation of phenol

A paraffin wax melting at approximately 120° F. and predominantly comprised of compounds having at least twenty carbon atoms in their molecules is melted and heated to about 200° F., after which chlorine is bubbled therethrough until the wax has absorbed about 16 percent of chlorine, such product having an average composition between a monochlor wax and a dichlor wax. Preferably, the chlorination is continued until about one-sixth the weight of the "chlor-wax" formed is chlorine. A quantity of chlor-wax thus obtained, containing two atomic proportions of chlorine, is heated to a temperature varying from just above its melting point to not over 150° F., and one mol of phenol (C_6H_5OH) is admixed therewith. The mixture is heated to about 150° F., and a quantity of anhydrous aluminum chloride corresponding to about 3 percent of the weight of chlor-wax in the mixture is slowly added with active stirring. The rate of addition of the aluminum chloride should be sufficiently slow to avoid violent foaming, and during such addition the temperature should be held at about 150° F. After the aluminum chloride has been added, the temperature of the mixture may be increased slowly over a period of from 15 to 25 minutes to a temperature of about 250° F. and then should be more slowly increased to about 350° F. To control the evolution of HCl gas the temperature of the mixture is preferably raised from 250° F. to 350° F., at a rate of approximately one degree per minute, the whole heating operation occupying approximately two hours from the time of adding the aluminum chloride. If the emission of HCl gas has not ceased when the final temperature is reached, the mixture may be held at 350° F. for a short time to allow completion of the reaction. However, to avoid possible cracking of the wax, the mixture should not be heated appreciably above 350° F., nor should it be held at that temperature for any extended length of time.

It is important that all unreacted or non-alkylated hydroxyaromatic material (phenol) remaining after the alkylation reaction be removed. Such removal can be effected generally by water-washing, but it is preferable to treat the water-washed product with superheated steam, thereby insuring complete removal of the unreacted material and accomplishing the drying of the product in the same operation.

A wax-substituted phenol prepared according to the above procedure in which a quantity of chlor-wax containing two atomic proportions of chlorine and having a chlorine content of 16 percent is reacted with 1 mol of phenol will be hereinafter designated as "wax-phenol (2–16)."

B. Formation of final product

Fifty grams of wax-phenol (2–16), prepared according to the foregoing procedure, and 5.6 grams of a 66 percent solution of ethylene diamine in water were dissolved in butyl alcohol. To the resulting alcohol solution, 2.55 grams of a 37 percent solution of formaldehyde in water—Formalin—were added dropwise, and the reaction mixture was stirred for two hours at room temperature (about 25° C.). The reaction mixture was then allowed to stand for 48 hours and thereafter heated for two hours at reflux, about 110° C. Eighty grams of a mineral oil (S. U. V. of 65 seconds @ 210° F.) were then added to the reaction mixture, and butyl alcohol was distilled therefrom, the maximum distillation temperature being 190° C. at 10 mms. pressure. The oil blend (2:5) of the reaction product thus obtained contained 2.3 percent nitrogen. This material is identified hereinafter as "Product One."

EXAMPLE II

A. Alkylation of phenol

A paraffin wax melting at approximately 120° F. and predominantly comprised of compounds having at least twenty carbon atoms in their molecules was melted and heated to about 200° F., after which chlorine was bubbled therethrough according to the procedure followed in Example I, section A, except that the chlorination was continued until the wax had absorbed about 16 percent chlorine. A quantity of chlor-wax thus obtained, containing 3 atomic proportions of chlorine, was heated to a temperature varying from just above its melting point to not over 150° F., and 1 mol of phenol (C_6H_5OH) was admixed therewith. The mixture was then subjected to the procedure followed in Example I to give a wax-substituted phenol which will be hereinafter designated as "wax-phenol (3–16)."

B. Final product

Seven hundred grams of wax-phenol (3–16), prepared according to the foregoing procedure, and 61.2 grams of a 60 percent solution of ethylene diamine in water were dissolved in butyl alcohol. To the alcohol solution were added dropwise 82.8 grams of Formalin. After stirring at room temperature (about 25° C.) for two hours, the reaction mixture was heated at reflux temperature (110° C.) for 6 hours. The reaction mixture was washed with four separate portions of water, the last wash water having a pH of 7. Butyl alcohol was removed from the reaction mixture by distilling the same to a maximum temperature of 185° C. at 10 mms. pressure. The final product—Product Two—is a wax-like substance having a nitrogen content of 1.73 percent.

EXAMPLE III

One hundred grams of wax-phenol (3–16), prepared as described in Example II, section A, 15.8 grams of ortho-phenylene diamine, 100

grams of mineral oil (S. U. V. of 65 seconds at 210° F.) and 150 cc. of butanol were heated to about 50° C. to form a clear solution. Aldol (β-hydroxybutyraldehyde), 25.6 grams, was added to the alcohol solution thus obtained over a period of 5 minutes. After heating the resulting reaction mixture to the reflux temperature (110° C.) for eight hours, the reaction mixture was water-washed until the wash water was neutral. Butyl alcohol was then removed by distilling the water-washed reaction mixture to a maximum temperature of 190° C. at 10 mms. pressure. The mineral oil blend (1:2) of the reaction product contained 1.6 percent nitrogen, and is identified hereinafter as Product Three.

Other typical examples in which the hydroxy-aromatic compound contains a different alkyl substituent, or no such substituent, are provided below.

Example IV

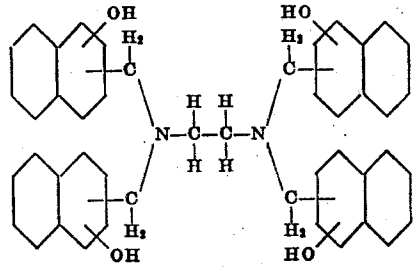
Seventy-eight grams of diamyl phenol, 27 grams of Formalin and 29 grams of a 69 percent solution of ethylene diamine in water were dissolved in a mixture of butyl and methyl alcohols. The alcoholic solution thus obtained was stirred at about 25° C. for 4 hours and then allowed to stand for 48 hours. Thereafter it was stirred again at 25° C. for 5 hours. After one water-wash, the alcohols and any unreacted diamyl phenol were removed from the reaction mixture by distilling the same to 230° C. at 10 mms. pressure. The product — Product Four — thus obtained is an oil-soluble, low melting resinous substance having a nitrogen content of 5.7 percent.

Example V

Thirty grams of a 95 percent solution of ethylene diamine in water were dissolved in butyl alcohol, and 45 grams of Formalin were added thereto while cooling the reaction vessel with an ice bath. Butyl alcohol was evaporated from the reaction mixture so obtained until white crystals formed therein. After cooling the reaction mixture, the crystals were filtered therefrom. The crystals were recrystallized from butyl alcohol. They are soluble in ether, ethyl alcohol, water and mineral oil, but insoluble in petroleum ether. They have a melting point of 163–165° C. and a nitrogen content of 30.96 percent.

Two grams of the crystals obtained above were dissolved in 95 percent ethyl alcohol; three grams of β-naphthol were similarly dissolved, and the two alcoholic solutions were mixed. On cooling in an ice bath, pale yellow crystals formed. The crystals were filtered from the alcohol solution and were thoroughly washed with 95 percent ethyl alcohol. The crystals were then dried at room temperature (25° C.). They had a melting point of 152° C. and a nitrogen content of 4.4 percent.

It is believed that this material—Product Five—is substantially pure:



As stated hereinbefore, the reaction products contemplated by this invention and illustrated by the above examples, when added to lubricating oils in minor proportions, have been found to improve these oils in several important respects. This phenomenon is demonstrated by the following tables, which give the results of the various tests conducted to determine the effectiveness of these reaction products as addition agents for lubricating oils. The percent of material added to the oil in the following tables is the percent of concentrated material and does not include the oil in which the product was made.

Pour Point Depression

Tests were conducted in the conventional manner to determine the A. S. T. M. pour points of blends of these reaction products with a Mid-Continent solvent-refined oil of Saybolt Universal viscosity of 67 seconds at 210° F. as compared with the pour point of the blank oil. The results given in Table I below demonstrate the effectiveness of the reaction products contemplated herein as pour point depressants.

Table I

Addition Agent	Percent Added	A. S. T. M. Pour Point Values
		°F.
None		+25
Product One	¼	−15
Product Two	⅛	−10
Product Three	⅛	−5

Corrosion Test

In this test the reaction product was blended with a Pennsylvania solvent-refined oil of Saybolt Universal viscosity of 53 seconds at 210° F., and a section of a bearing containing a cadmium-silver alloy surface and weighing about 6 grams was added to this blend. The oil was heated to 175° C. for 22 hours while a stream of air was bubbled against the surface of the bearing. The loss in weight of the bearing during this treatment measured the amount of corrosion that had taken place. A sample of the straight oil was subjected to the same test at the same time, and the difference between the losses in weight of the two bearing sections demonstrated conclusively the effectiveness of the reaction products contemplated herein as corrosion-inhibitors.

Table II

Addition Agent	Percent Added	Bearing Loss, mgms.	
		Inhibited Oil	Uninhibited Oil
Product One	1/10	0	33
Do	1/50	2	37
Product Two	1/10	0	33
Product Three	1/10	1	39
Product Four	1/20	0	33
Do	1/100	2	37

Socony-Vacuum Turbine Test

Twenty-five cc. samples of a furfural-refined Rodessa crude of Saybolt Universal viscosity of 150 seconds at 100° F. and of blends of this same oil and typical reaction products were subjected to the following test to determine the effectiveness of the reaction products contemplated by this invention as inhibitors for turbine oils: To each sample were added 1 gram of iron granules and 24 inches of 18 gauge copper wire. The samples

were then heated to a temperature of 200° F. with 5 liters of air per hour bubbling therethrough. Two cc. of distilled water were added each day. The results of the tests which were made for color and acidity or neutralization number and amount of sludge formed after certain time intervals are set forth in Table III below.

Table III

Addition Agent	Percent Added	Hours	Lovibond Color	N. N.	Sludge in mgms.
None		162	245	17.8	839
Product One	¼	166	5.5	0.01	0
		660	14.0	3.00	27
Product Five	1/10	167	2.0	0.01	7
		660	145	0.31	39

RUST TEST

A cold rolled steel disc (1 inch in diameter and ¼ inch thick) with 1 highly polished concave surface facing upward was placed in a 50 ml. glass beaker. A 25 ml. sample of the oil or oil blend was introduced into the beaker, which was held in a constant temperature bath at 90° F., for 30 minutes. One-tenth (0.1) ml. of distilled water was carefully added so that 1 drop of water rested on the concave surface of the steel disc. The steel disc was then observed for the first appearance of rust and the time recorded. The oil used was an acid-treated oil of 148–155 seconds S. U. V. at 100° F. The results of these tests are shown in Table IV following:

Table IV

Addition Agent	Percent Added	Time for Rust to Appear
None		15 minutes.
Product Two	1/10	No rust in 18 hours.

OPERATION TEST

To demonstrate the effectiveness of the reaction products under actual operating conditions of an automotive engine, unblended oils and improved oils, containing the reaction products, were subjected to the Lauson engine test. The tests were carried out in a single-cylinder Lauson engine operated continuously over a time interval of 16 hours with the cooling medium held at a temperature of about 212° F., and the oil temperature held at about 280° F. The engine was operated at a speed of about 1830 R. P. M. At the end of each test the oil was tested for acidity (N. N.) and viscosity. The base oil used here is a solvent refined oil having an S. U. V. of 44 seconds at 210° F.

Table V

Addition Agent	Percent Added	S. U. V. @ 210° F.	N. N.
None		50.7	5.5
Product One	½	44.9	0.5
None		50.7	4.9
Product One	¼	45.7	1.1

It will be apparent from the foregoing test data that the reaction products of this invention are effective not only to inhibit corrosion and the various effects of oxidation upon mineral oils, such as formation of rust, sludge, color bodies and other undesirable products, but also to depress the pour point.

The improved properties obtained and the degree of improvement effected may be varied with the aldehyde, polyamine and hydroxyaromatic compounds. For example, when the hydroxyaromatic nucleus contains one or more of the preferred "wax" substituents, the reaction product obtained therewith is characterized by pour depressant action and an extremely high order of rust inhibiting properties.

The amount of improving agent used varies with the mineral oil or lubricating oil fraction with which it is blended and with the properties desired in the final oil composition. These reaction products may be added to mineral oil in amounts of from about 0.001 to about 10 percent, but amounts of from about 0.1 percent to about 3 percent generally provide satisfactory improvement.

It is to be understood that although I have described certain preferred procedures which may be followed in the preparation of the novel reaction products contemplated herein as multifunctional addition agents for mineral oils and have indicated representative reactants for use in their preparation, such procedures and reactants are merely illustrative and the invention is not to be considered as limited thereto or thereby but includes within its scope such changes and modifications as fairly come within the spirit of the appended claims.

I claim:

1. An improved mineral oil containing a minor proportion, sufficient to depress the pour point and improve the oxidation stability of said oil, of a reaction product obtained by reaction, at a temperature within the range of from about 25° C. to about 110° C., of an aldehyde, a hydroxyaromatic compound and a polyamine in which each amino group has at least on hydrogen atom; the proportions of reactants, on the basis of one mol of aldehyde, being about one mol of hydroxyaromatic compound and at least about one-fourth mol of polyamine.

2. An improved mineral oil containing a minor proportion, from about 0.001 percent to about 10 percent, of a reaction product obtained by reaction, at a temperature within the range of from about 25° C. to about 110° C., of an aldehyde, a hydroxyaromatic compound and a polyamine in which each amino group has at least one hydrogen atom; the proportions of reactants, on the basis of one mol of aldehyde, being about one mol of hydroxyaromatic compound and at least about one-fourth mol of polyamine.

3. An improved mineral oil containing a minor proportion, sufficient to depress the pour point and improve the oxidation stability of said oil, of a reaction product obtained by reaction, at a temperature within the range of from about 25° C. to about 110° C., of an aliphatic aldehyde, a hydroxyaromatic compound and a polyamine in which each amino group has at least one hydrogen atom: the proportions of reactants, on the basis of one mol of aliphatic aldehyde, being about one mol of hydroxyaromatic compound and at least about one-fourth mol of polyamine.

4. An improved mineral oil containing a minor proportion, sufficient to depress the pour point and improve the oxidation stability of said oil, of a reaction product obtained by reaction, at a temperature within the range of from about 25° C. to about 110° C., of formaldehyde, a hydroxyaromatic compound and a polyamine in which each amino group has at least one hydrogen atom; the proportions of reactants, on the basis

of one mol of formaldehyde, being about one mol of hydroxyaromatic compound and at least about one-fourth mol of polyamine.

5. An improved mineral oil containing a minor proportion, sufficient to depress the pour point and improve the oxidation stability of said oil, of a reaction product obtained by reaction, at a temperature within the range of from about 25° C. to about 110 C., of an aldehyde, a hydroxyaromatic compound and an aliphatic polyamine in which each amino group has at least one hydrogen atom; the proportions of reactants, on the basis of one mol of aldehyde, being about one mol of hydroxyaromatic compound and at least about one-fourth mol of aliphatic polyamine.

6. An improved mineral oil containing a minor proportion, sufficient to depress the pour point and improve the oxidation stability of said oil, of a reaction product obtained by reaction, at a temperature within the range of from about 25° to about 110°, of an aldehyde, a hydroxyaromatic compound and an aliphatic polyamine having two primary amino groups attached to adjacent carbon atoms; the proportions of reactants, on the basis of one mol of aldehyde, being about one mol of hydroxyaromatic compound and at least about one-fourth mol of polyamine.

7. An improved mineral oil containing a minor proportion, sufficient to depress the pour point and improve the oxidation stability of said oil, of a reaction product obtained by reaction, at a temperature within the range of from about 25° C. to about 110° C., of an aldehyde, a hydroxyaromatic compound and ethylene diamine; the proportions of reactants, on the basis of one mol of aldehyde, being about one mol of hydroxyaromatic compound and at least about one-fourth mol of ethylene diamine.

8. An improved mineral oil containing a minor proportion, sufficient to depress the pour point and improve the oxidation stability of said oil, of a reaction product obtained by reaction, at a temperature within the range of from about 25° C. to about 110° C., of an aldehyde, an alkyl-substituted hydroxyaromatic compound wherein the alkyl substituent contains at least twenty carbon atoms and a polyamine in which each amino group has at least one hydrogen atom; the proportions of reactants, on the basis of one mol of aldehyde, being about one mol of alkyl-substituted hydroxyaromatic compound and at least about one-fourth mol of polyamine.

9. An improved mineral oil containing a minor proportion, sufficient to depress the pour point and improve the oxidation stability of said oil, of a reaction product obtained by reaction, at a temperature within the range of from about 25° C. to about 110 C., of an aldehyde, a wax-substituted hydroxyaromatic compound and a polyamine in which each amino group has at least one hydrogen atom; the proportions of reactants, on the basis of one mol of aldehyde, being about one mol of wax-substituted hydroxyaromatic compound and at least about one-fourth mol of polyamine.

10. An improved mineral oil containing a minor proportion, sufficient to depress the pour point and improve the oxidation stability of said oil, of a reaction product obtained by reaction, at a temperature within the range of from about 25° C. to about 110° C., of an aldehyde, a wax-phenol and a polyamine in which each amino group has at least one hydrogen atom; the proportions of reactants, on the basis of one mol of aldehyde, being about one mol of wax phenol and at least about one-fourth mol of polyamine.

11. An improved mineral oil containing a minor proportion, sufficient to depress the pour point and improve the oxidation stability of said oil, of a reaction product obtained by reaction, at a temperature within the range of from about 25° C. to about 110° C., of an aldehyde, diamyl phenol and a polyamine in which each amino group has at least one hydrogen atom; the proportions of reactants, on the basis of one mol of aldehyde, being about one mol of diamyl phenol and at least about one-fourth mol of polyamine.

12. An improved mineral oil containing a minor proportion, sufficient to depress the pour point and improve the oxidation stability of said oil, of a reaction product obtained by reaction, at a temperature within the range of from about 25° C. to about 110° C., of an aldehyde, β-naphthol and a polyamine in which each amino group has at least one hydrogen atom; the proportions of reactants, on the basis of one mol of aldehyde, being about one mol of β-naphthol and at least about one-fourth mol of polyamine.

13. An improved mineral oil containing a minor proportion, sufficient to depress the pour point and improve the oxidation stability of said oil, of a condensation product obtained by reaction, at a temperature within the range of from about 25° C. to about 110° C., of formaldehyde, wax-phenol and ethylene diamine; the proportions of reactants, on the basis of one mol of formaldehyde, being about one mol of wax phenol and at least about one-fourth mol of ethylene diamine.

14. An improved mineral oil containing a minor proportion, sufficient to depress the pour point and improve the oxidation stability of said oil, of a condensation product obtained by reaction, at a temperature within the range of from about 25° C. to about 110° C., of formaldehyde, diamyl phenol and ethylene diamine; the proportions of reactants, on the basis of one mol of formaldehyde, being about one mol of diamyl phenol and at least about one-fourth mol of ethylene diamine.

15. An improved mineral oil containing a minor proportion, sufficient to depress the pour point and improve the oxidation stability of said oil, of a condensation product obtained by reaction, at a temperature within the range of from about 25° C. to about 110° C., of β-naphthol and a product obtained by reaction of formaldehyde and ethylene diamine; the proportions of reactants, on the basis of one mol of formaldehyde, being at least about one-fourth mol of ethylene diamine and about one mol of β-naphthol.

16. A mineral oil concentrate containing upwards of 10% of a reaction product obtained by reaction, at a temperature within the range of from about 25° C. to about 110° C., of an aldehyde, a hydroxyaromatic compound and a polyamine in which each amino group has at least one hydrogen atom; the proportions of reactants, on the basis of one mol of aldehyde, being about one mol of hydroxyaromatic compound and at least about one-fourth mol of polyamine.

EDWARD A. OBERRIGHT.

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