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EXTREME PRESSURE SOLUBLE OIL COMPOSITIONS

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The present invention relates to improved soluble oil compositions which, when emulsified with water, form stable emulsions of high load carrying capacity.

In the metal fabricating, cutting and related arts, use is made of emulsions which function to lubricate and cool the metal and cutting tools used in turning, drilling, grinding and similar operations. In many of such operations, the emulsions are prepared by emulsifying a suitable soluble oil with a relatively large proportionate amount of water. The soluble oils employed usually contain as essential ingredients a lubricating base, an emulsifying agent and water and, for contemplated use in heavy duty machining operations such as the high speed cutting of hard alloy steels, the soluble oils generally contain a suitable extreme pressure agent. The ingredients used in soluble oils are generally employed in rather well defined proportionate amounts so that the soluble oil itself will be a homogeneous solution stable against ingredient separation, will readily emulsify with formation of a stable emulsion when added to and agitated with a relatively large proportionate amount of water and in such emulsified form, will possess a high load carrying capacity.

Although the art is aware of soluble oils that contain materials other than of petroleum origin as the lubricating base, the most widely used, to my knowledge, are soluble oils in which the lubricating base is of petroleum origin and may comprise a mineral oil that boils in the lubricating oil boiling range, a spindle oil, a pale oil or types similar thereto. Lubricating bases used for soluble oils include distillate oils derived from petroleum crudes and which may vary over a rather wide range of viscosity, the particular viscosity employed being determined primarily by the contemplated usage of the soluble oil. For most purposes, however, lubricating bases having a viscosity not exceeding about 500 SUS at 100° F. have been employed, an illustrative example thereof being distillate oils having a viscosity of about 100 SUS at 100° F. and one reason for usage of mineral oils of the lower viscosity characteristics is that, in general, they may be rendered emulsifiable more readily than high viscosity oils.

The art is also aware of many emulsifying agents usable in soluble oils to facilitate the dispersability and emulsifiability of the lubricating base with water. In illustration, emulsifying agents used for soluble oils include metal or onium base soaps of organic acids such as the alkali metal or onium base soaps of fatty acids, naphthenic acids, and sulfonic acids. As examples of the organic soaps, the oleates of alkylol amines such as the di- and tri-ethanol amine oleates have been employed and, of the metal soaps, use has and is still being made of alkali metal soaps of organic acids such as the fatty acids, sulfonic acids, naphthenic acids and the like, with sodium and potassium soaps of such acids being more specific illustrations.

With reference to soluble oil compositions that contain an extreme pressure agent, numerous materials are

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known to the art that impart extreme pressure properties to such compositions. Materials used include elemental sulfur, sulfur-containing materials such as sulfurized fatty oils, sulfurized ester waxes such as sulfurized sperm oil, sulfur chloride treated fatty acids, and others. Also used as extreme pressure agents are phosphorus-containing materials illustrated by the product marketed as "Ortholeum 153" by E. I. du Pont de Nemours and Co., Inc., and understood to comprise tricresyl phosphate and chlorine-containing substances such as chlorinated hydrocarbons marketed as "Chlorinated Hydrocarbon-70" by the Pennsylvania Salt Manufacturing Company of Philadelphia, Pa. and having a chlorine content of 67-70 percent by weight.

Additionally, numerous soluble oils, and particularly those containing a metal soap as an emulsifier, contain coupling agents adapted to facilitate dispersion of the emulsifying agent in the oil. Coupling agents used include alcohols of the aliphatic type such as the propanols and butanols, polyhydric alcohols such as the glycols and more specifically diethylene glycol, glycol ethers such as diethylene glycol monobutyl ether, and combinations thereof. Illustrative of such agents in combination is diethylene glycol with diethylene glycol monobutyl ether with suitable results being obtained by use in soluble oils of a combination, based on the weight of the soluble oil, of about 0.3 to about 3 percent of a polyhydric alcohol and an amount of the alcohol ether of from about one to about five times that of the polyhydric alcohol.

Water, in addition to being an essential ingredient in soluble oils, must be correlated with the remaining ingredients of the composition in order to provide a soluble oil that is homogeneous and stable against ingredient separation and which readily forms stable emulsions when added to relatively large proportionate amounts of water to form the compositions ready for use in cutting operations and the like. For example, soluble oils that contain water, but in an insufficient amount, have a tendency to gel, whereas soluble oils that contain an excessive amount of water usually evidence instability caused by the soap separating out of solution. Thus, and with respect to a particular soluble oil composition a rather well defined range of water will be tolerated thereby. Addition of water to the composition in an amount in excess of that tolerated leads to formation of a cloudy or hazy appearance and oftentimes stratification occurs due to ingredient separation. Generally speaking, the more water within limits which can be tolerated by a soluble oil in stable solution, the more stable will be the emulsion resulting from later addition of the soluble oil to a relatively large proportionate amount of water necessary to prepare it for use. In certain soluble oil compositions increased amounts of water can be tolerated by increasing the soap content but use of such an expedient is not desirable from an economic viewpoint as soap is one of the more expensive of the ingredients used. Provision of soluble oils having increased tolerances for water without necessitating use of increased soap content are desirable not only from an economic viewpoint but also because they minimize the need for critical control during manufacture as compared to preparation of soluble oils having narrower ranges of water tolerance.

It is an object of the present invention to provide novel stable homogeneous soluble oil compositions that have an exceedingly wide range of water tolerance and readily form stable emulsions of high load carrying capacity. Another object is to provide novel stable homogeneous soluble oil compositions possessing an exceedingly wide range of water tolerance and possessing high load carrying capacity without requiring exceptionally large

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amounts of extreme pressure agents. Still another object is to provide stable homogeneous soluble oil compositions that contain a novel combination of ingredients whereby the compositions possess an exceedingly wide water tolerance, readily form stable emulsions that possess a high load carrying capacity and which, due to their high water tolerance, may be prepared without need of critical control as compared to oils of lesser water tolerance characteristics. It is still another object to provide such stable homogeneous soluble oils of low soap content that possess a high water tolerance and are capable of forming emulsions that possess an exceedingly high load carrying capacity with low concentrations of extreme pressure agents.

The present invention relates to stable, homogeneous liquid compositions adapted for use as soluble oils that possess desired properties as aforesaid and which result by use, as a lubricating base in the composition, of a suitable solvent extract of petroleum origin. The lubricating base employed may consist of the solvent extract per se or mixtures thereof with a mineral oil. Hence, the compositions embodied herein comprise a lubricating base, an emulsifying agent, an extreme pressure agent, water in an amount sufficient to inhibit the composition against gelation but less than an amount sufficient to induce ingredient separation, and are further characterized in that the lubricating base contains a solvent extract of petroleum origin.

Mineral oil solvent extraction processes are well known to those experienced in the art and since the extraction processes per se are not a part of the present invention it is not deemed essential to describe such processes in detail herein. For purposes of illustration, however, such solvent extraction processes entail use of solvents such as beta, beta-di-chloroethyl ether, furfural, phenol and other suitable solvents under extraction conditions to preferentially extract from the mineral oils the aromatic-containing molecules therein. In more specific illustration, furfural is a widely used and typical extraction solvent and, for purposes of illustration, extracts from mineral oils by use of such a solvent are employed herein to describe this invention.

The improved soluble oil compositions obtained by practice of the present invention are illustrated by the data in the following tabulation (Table I) which includes compositions as embodied herein and a conventional soluble oil, in which the lubricating base component was devoid of a solvent extract of petroleum origin, used for comparative purposes. The compositions set forth in

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Concentrate:	Percent by weight
"Soap solution" -----	64.6
Tall oil -----	5.2
NaOH (50 Bé.) -----	3.0
Diethylene glycol -----	5.5
Ethylene glycol monobutyl ether -----	12.7
Water -----	9.0
	100.0

The ingredient shown as "soap solution" as used herein comprises about 60 percent of the water soluble sodium salts of mahogany acids derived from petroleum, about 5 percent water, and the balance mineral oil. The ingredients are shown in formula amounts, soaps being formed by action of the sodium hydroxide with the tall oil prior to blending with the remaining constituents.

The extract employed in preparation of the extract-containing compositions in the tabulation was a furfural extract per se obtained from a Pennsylvania crude oil by subjecting the oil to distillation from which a pressable distillate was obtained, said distillate being press dewaxed and subjected to distillation to remove gas oil and yield a bottoms fraction. The bottoms fraction was then solvent extracted with furfural to yield an extract comprised predominantly of aromatic-containing molecules and having the following characteristics:

Gravity, API -----	7.8
Flash point ----- ° F	405
Fire point ----- ° F	475
Viscosity at 100° F ----- SUS	2765
Viscosity at 210° F ----- SUS	71.7
Carbon residue -----	0.91

The load carrying capacity of the compositions shown in Table I were obtained on a Falex tester in which test the loads were applied gradually while rotating the pin at a constant speed. This device, which is a well-known lubricant testing machine, comprises a steel pin rotatable between two nonrotatable steel jaws carrying V-shaped bearing surfaces and means for clamping the rotating pin between the bearing surfaces with adjustable force. In conducting the test, the oil emulsion under observation was kept in contact with the revolving pin while the latter was clamped between the bearings with steadily increasing force applied to the jaws. The amount of force, as indicated on the load gauge of the machine, required to cause seizure between pin and bearings represents failure of the test composition.

Table I

Composition No.	Composition (By Weight)					Load Carrying Capacity (Average) of Emulsion (10% of composition and 90% water) Gauge Reading in Pounds
	Mineral Oil	Extreme Pressure Agent	Extract	Concentrate	Water (Over and above water in concentrate)	
1 -----	59 (100 Pale) ¹	18 (Sulfurized Sperm Oil) -----		23		3,500.
2 -----		do -----	59	23		Entire load of Falex tester (4,500 +).
3 -----		10 (Sulfurized Sperm Oil) -----	70	20		Do.
4 -----	12 (100 Pale) -----	9 (Sulfurized Sperm Oil) -----	52	18	9	Do.
5 -----	12 (55 Pale) ² -----	do -----	52	18	9	Do.
6 -----	12 (#2 Fuel) ³ -----	do -----	51	18	10	Do.
7 -----	13 (#2 Fuel) -----	5 (Chlorinated Hc. 70) -----	62	20		Do.
8 -----	do -----	10 ("Ortholeum 153") -----	57	20		Do.

¹ Viscosity of 100 SUS at 100° F.

² Viscosity of 55 SUS at 100° F.

³ Petroleum distillate (#2 Fuel Oil) with viscosity of 35-40 SUS at 100° F.

the tabulation were, in each instance, prepared by blending a concentrate and extreme pressure agent with the lubricating base, the concentrate employed having the following composition:

Referring to Table I, composition No. 1 relates to a soluble oil containing sulfurized sperm oil as the extreme pressure agent and, as the lubricating base, a mineral oil conventionally used in soluble oil compositions.

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Composition No. 2 was identical to composition No. 1 except that the lubricating base was a solvent extract. As shown, use of the solvent extract as the lubricating base produced a composition having a markedly increased load carrying capacity. The marked improvement in load carrying capacity imparted to such compositions by use of the solvent extract is even more apparent upon reference to composition No. 3 which, although it contained only 10 per cent of the extreme pressure agent, carried the entire load of the Falex tester whereas composition No. 1 (of 18% sulfurized sperm content) did not carry the load to such an extent. Composition Nos. 4 to 6, inclusive, although containing only one-half of the extreme pressure agent content of composition No. 1, also carried the entire load of the Falex tester. As shown, composition Nos. 4 to 6 contained,

was a clear stable homogeneous liquid composition but which, upon further addition of water, evidenced instability by developing a cloudy appearance. The remaining compositions in Table II relate to compositions as embodied herein and, as shown, such compositions possess substantially higher tolerances for water. Compositions 10 to 13, containing the extract per se or in mixture thereof with a mineral oil as the lubricating base, possessed substantially higher water tolerances as compared to composition 9 even though compositions 10 to 13 contained a lower percentage of soap and a larger proportion of lubricating base to soap. Thus, and as shown by the data in Table I and Table II, the practice of the present invention enables preparation of compositions of relatively high load carrying capacities and exceptionally wide tolerances for water.

Table II

Composition No.	Composition (By Weight)					Ratio of Lubricating Base to Concentrate
	Mineral Oil	Sulfurized Sperm Oil	Extract	Concentrate	Approximate Maximum Amount of Water Tolerated (in addition to water in concentrate)	
9-----	58.5 (100 Pale)-----	17.9	-----	22.8	0.8	2.6:1
10-----	-----	9.9	68.9	19.7	1.5	3.1:1
11-----	11.5 (100 Pale)-----	9.0	50.7	17.8	11.0	3.5:1
12-----	11.5 (55 Pale)-----	9.0	50.7	17.8	11.0	3.5:1
13-----	11 (#2 Fuel)-----	8.4	48.0	16.6	16.0	3.6:1

as the lubricating base, a mixture of the solvent extract with low viscosity mineral oil fractions ranging from the mineral oil of 100 SUS at 100° F. of composition No. 4 to the No. 2 fuel oil of composition No. 6. A feature of the compositions as illustrated by Nos. 4 to 6 is that, as compared to composition 1, they not only contained a much lower concentration of extreme pressure agent but also a lower content of soap as they contained less concentrate than composition 1. Composition Nos. 7 and 8 have been included to illustrate embodiments of the invention using, as an extreme pressure agent, a substance other than sulfur-containing compounds. Specifically, composition Nos. 7 and 8 relate to chlorine-containing substances and phosphorus-containing substances, respectively, as extreme pressure agents and the data pertaining to the relatively high load carrying capacity possessed thereby shows that compositions based on a lubricating base containing the solvent extract, in accordance with this invention, may be prepared with relatively high load carrying capacity by use of agents chemically different from the sulfur-containing substance of compositions 1 to 6, inclusive.

Whereas the foregoing tabulation relates to compositions as embodied herein and the relatively high load carrying characteristics thereof, the following tabulation (Table II) illustrates compositions as embodied herein with data pertaining to water tolerance characteristics. The data shown in the table in the column entitled "Approximate Maximum Amount of Water Tolerated" relates to the percentage by weight of water which could be incorporated in the compositions shown, over and above the amount of water in the concentrate, without substantial, if any, evidence of instability of the composition. In Table II composition No. 9 relates to a conventional soluble oil consisting of a conventional mineral oil as a lubricating base, sulfurized sperm oil as an extreme pressure agent, and the concentrate described hereinbefore. Such a composition tolerated a maximum of about 0.8 percent of water over and above the water in the concentrate. Composition No. 9, containing the ingredients and amounts thereof set forth in the table,

As aforescribed, the compositions of the present invention comprise a lubricating base, an emulsifying agent, an extreme pressure agent, and water with the lubricating base generally being the major component, based upon the weight of the composition. When, as aforescribed, the lubricating base comprises a mixture of the extract with mineral oil, the relative proportion of extract to mineral oil in the lubricating base may be varied over a rather wide range, depending upon factors such as the ultimate viscosity desired, obtainment of which is facilitated by blending of the viscous extract with a low viscosity mineral oil, the desired increase in water tolerance as compared to the mineral oil per se as the lubricating base, and the like. As to the mineral oil component of the lubricating base, suitable therefor are liquid fractions obtained as petroleum distillates such as those having a viscosity up to about 200 SUS at 100° F. and, in some instances, even higher, but usage of low viscosity petroleum distillates such as those in the No. 2 fuel oil range (e. g. 35-40 SUS at 100° F.), low viscosity pale oils (e. g. 55 SUS at 100° F.), and higher viscosity pale oils (e. g. 100 SUS at 100° F.), is preferred. Although the relative amount of a mineral oil fraction to extract may be varied depending upon factors such as aforesaid, and additionally upon volatility characteristics desired for the soluble oil composition, highly suitable compositions as embodied herein comprise the extract in a major amount by weight based on the weight of the lubricating base.

As is apparent from the illustrative compositions set forth hereinbefore, the amount of extreme pressure agent employed may also be varied over a rather wide range based upon the weight of the composition, as illustrated by an amount as low as 5 percent in composition No. 7 and 18 percent in composition No. 2, and the concentrations in-between said amounts as used in the other examples. It should be understood, however, that although the amounts used in the foregoing examples provide highly suitable compositions as embodied herein, the invention is not limited thereto as it is within the scope of the present invention to use amounts less

than or higher than the concentrations shown, depending upon particular results desired, as the described improvements resulting from use of the solvent extract in the lubricating base may be effected in compositions containing extreme pressure agents in amounts other than those specifically set forth hereinbefore. However, in most cases, the amount of extreme pressure agent employed is generally in amounts of from about 2 to about 25 percent by weight of the composition. With reference to the extreme pressure agents, use of sulfur-containing materials is preferred although, as shown hereinbefore, the invention may be satisfactorily practiced with use of other extreme pressure agents, and particularly, oil-soluble chlorine-containing and phosphorus-containing extreme pressure agents.

Moreover, and due to the exceptionally wide range of water tolerated by compositions as embodied herein, it is obvious that such compositions may be prepared that contain water in amounts that vary considerably, based on the weight of the composition. In broad aspect, therefore, the amount of water present in the composition should be sufficient to inhibit gelation but less than an amount sufficient to induce ingredient separation. Although the amount of water tolerated by compositions as embodied herein depends on factors such as the amount of extract in the lubricating base or the amount of soap employed, and the like, it is apparent from the foregoing data that compositions containing relatively high amounts of water may be prepared that are stable, homogeneous solutions and form stable oil-in-water emulsions, i. e. the type of emulsion desired in the use of soluble oils for preparation of lubricating and coolant compositions in metal fabricating compositions. Illustrative of such compositions is composition No. 13, which contains about 18 percent water, consisting of the water present in the concentrate plus the amount (16 percent) shown as water tolerated over and above that in the concentrate.

Although the present invention has been described in conjunction with certain preferred embodiments thereof, those skilled in the art will readily recognize that variations and modifications can be made. Such modifications and variations are to be considered to be within the purview of the specification and scope of the appended claims.

I claim:

1. A stable soluble oil composition comprising, in homogeneous solution, a lubricating base in major amount based upon the weight of the composition a predominantly aromatic extract obtained by furfural extraction of a mineral oil fraction, a water-soluble soap as an emulsifying agent, an extreme pressure agent, and water in an amount sufficient to inhibit said composition against gelation but less than an amount sufficient to induce separation of said composition.

2. A stable soluble oil composition comprising, in homogeneous solution, a lubricating base in major amount based upon the weight of said composition, a water-soluble soap as an emulsifying agent, an extreme pressure agent and water in an amount sufficient to inhibit gelation but less than an amount sufficient to induce separation of said composition, said lubricating base comprising (a) a predominantly aromatic extract obtained by furfural extraction of a petroleum fraction in mixture with (b) a mineral oil distillate having a viscosity not exceeding about 200 SUS at 100° F. and about 44 to 45 SUS at 210° F., said extract being present in

an amount substantially greater than the amount of said mineral oil distillate.

3. A composition, as defined in claim 2, wherein the soap is a metal soap of an organic acid.

4. A stable soluble oil composition comprising, in homogeneous solution, a lubricating base in major amount based upon the weight of the composition, a water soluble metal soap of an organic acid as an emulsifying agent, an extreme pressure agent from the group consisting of sulfur-containing, phosphorus-containing and chlorine-containing extreme pressure agents, and water in an amount sufficient to inhibit said composition against gelation but less than an amount sufficient to induce separation of said composition, said lubricating base comprising a predominantly aromatic extract obtained by furfural extraction of a petroleum fraction and a mineral distillate fraction having a viscosity not exceeding 200 SUS at 100° F. and about 44 to 45 SUS at 210° F., said extract being present in an amount substantially greater than the amount of said mineral oil distillate fraction.

5. A stable soluble oil composition comprising, in homogeneous solution, a lubricating base in major amount based upon the weight of the composition, a water-soluble soap as an emulsifying agent, an extreme pressure agent from the group consisting of sulfur-containing, phosphorus-containing and chlorine-containing extreme pressure agents, a coupling agent in an amount sufficient to disperse said soap in said lubricating base, and water in an amount sufficient to inhibit said composition against gelation but less than an amount sufficient to induce separation of said composition, said lubricating base comprising (a) an extract consisting essentially of the more aromatic-containing molecules extracted from a petroleum fraction with furfural which preferentially extracts the more aromatic-containing molecules from said petroleum fraction and (b) a mineral oil distillate fraction having a viscosity not exceeding about 200 SUS at 100° F. and about 44 to 45 SUS at 210° F., the amount of extract being substantially greater than the amount of said mineral oil distillate fraction.

6. A composition, as defined in claim 5, wherein the soap is a metal soap of an organic acid, and the coupling agent comprises a polyhydric alcohol and an alcohol ether.

7. A composition, as defined in claim 6, wherein the coupling agent is a mixture of a glycol and a glycol ether.

8. A composition, as defined in claim 7, wherein the glycol is diethylene glycol and the glycol ether is ethylene glycol monobutyl ether.

9. A composition, as defined in claim 5, wherein the soap is a sodium salt of petroleum mahogany acids, the extreme pressure agent is sulfurized sperm oil, and the coupling agent is a mixture of diethylene glycol and ethylene glycol monobutyl ether.

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