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SOLUBLE CUTTING OIL

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5 Claims. (Cl. 252—48.8)

This invention relates to improved lubricating compositions and more particularly to compositions adapted for lubrication and cooling of surfaces operated at high speeds and pressures such as are used in metal cutting operations. The so-called soluble sulfur-containing cutting oils should be readily emulsifiable in water so that relatively small quantities of oil may be mixed with relatively large amounts of water to provide a cutting compound for machining operations which has a high heat capacity and good extreme pressure properties. It is generally known that the cutting ability or extreme pressure characteristics of a sulfur-containing cutting oil improve with an increase in the concentration of sulfur in the oil. It is desirable that a cutting oil be as transparent as possible so as not to obscure the work being operated upon. The aims of workers in this art have included producing a cutting oil of sufficiently high stable sulfur concentration to impart good extreme pressure properties to the composition and at the same time preparing oils as transparent as possible.

In a co-pending application, Serial No. 252,995 filed October 24, 1951, by Harold H. Eby, now Patent No. 2,708,199, there is disclosed a method of converting olefin hydrocarbons into substantially saturated alkyl polysulfides of exceptionally high sulfur content. That method generally comprises the steps of reacting an olefin with a sulfur halide for a time sufficient to form a di(halo alkyl) sulfide intermediate and then condensing this intermediate with a solution of a water-soluble inorganic higher polysulfide to form an organic polysulfide which is substantially a dimer of the reactant olefin and having combined therewith from at least two to three atoms of sulfur per unsaturated linkage in the reactant olefin. The resulting products have a high sulfur content ranging between 30 and 60 per cent by weight depending on the olefin used.

It has now been discovered that these sulfur-bearing compounds may be used to produce improved extreme pressure soluble cutting oils. Because of their high sulfur content, less of the sulfur-bearing compound need be used than with the conventional type of sulfurized additives without any sacrifice of extreme pressure properties. At the same time stable emulsions can be obtained with the use of considerably less emulsifying material. The resulting cutting oil compositions when shop tested show superior results. They have good cooling qualities, give a superior finish, increase tool life, and do not leave any gummy deposits on machines.

It is an object of this invention, therefore, to produce improved soluble sulfur-bearing cutting oils containing the alkyl polysulfides prepared as outlined above.

It is a further object of this invention to produce an improved soluble sulfur-bearing cutting oil composition for emulsification with water before use in machining operations.

A still further object is to produce an improved soluble cutting oil having superior extreme pressure properties

containing smaller amounts of the sulfur-containing material and of the emulsifying agent than are required by prior art compositions.

Other objects of the invention will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, this invention then comprises the features hereinafter fully described and particularly pointed out in the claims, the following description setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principles of the invention may be employed.

Broadly stated, this invention comprises the formulation of a readily emulsifiable cutting oil composition comprising a mineral oil base and containing a minor amount of an olefin-derived polysulfide prepared by reacting a nonconjugated olefinic hydrocarbon having from at least six to about thirty carbon atoms with about a stoichiometric equivalent of a sulfur halide at a temperature of from about 0° C. to about 50° C. for a time sufficient to form a di(halo alkyl)sulfide intermediate but insufficient to effect dehydrohalogenation as evidenced by the substantial splitting out of hydrogen halide, then at once condensing this intermediate with a water-solube inorganic higher polysulfide at a temperature in the range of about 50 to 100° C. in a mutual solvent for a time not to exceed about four hours and upon completion separating out the product. The sulfur-bearing compound is essentially a dimer of the reactant olefin and has combined therewith from at least two to about three atoms of sulfur for each unsaturated linkage in the reactant olefin. The term "dimer" is used in the sense that two molecules of the reactant olefin are joined together by sulfur bridging.

To produce sulfur-containing compounds for cutting oils having desirable solubility characteristics, olefinic hydrocarbons are used containing at least six to about thirty carbon atoms. Straight and branch chain olefins, i. e., acylic olefins, generally are preferred. Cyclic olefins, although not fully equivalent, may be used to produce products which are more or less readily dispersible. The olefins which are employed are produced commercially in many ways. For example, by the dehydration of alcohols such as the C_6 and higher alcohols; from the cracking of hydrocarbon oils; from the polymerization of light olefins such as propylene, butylene, and amylene; or by the halogenation and dehydrohalogenation of saturated hydrocarbons. The olefin charge to the process may consist of a wide boiling mixture of olefins or may be a narrow boiling fraction or be a single pure olefin. First preference, however, is for a narrow cut olefin fraction, and second, for a pure olefin. Ordinarily olefin materials contaminated with saturated hydrocarbons are avoided, especially so among the high boiling olefins since such contaminants, although inert in the process, become diluents of the final products and cannot be readily separated therefrom. The raw material is usually monoolefinic; however, the nonconjugated diolefins above about C_{15} may also be used.

Specific olefins contemplated in the foregoing description are the propylene polymers such as hexene, nonene, dodecene, octadecylene, and the like; tri-isobutylene, 2 ethylhexene-1, octene-1, dodecene-1, wax-olefin, and the like. For dispersible rather than solube types of products, exemplary olefins include methyl cyclopentene, cyclohexene, and pinene.

The sulfur halide employed in the preparation of the polysulfide is preferably a sulfur chloride, and ordinarily the sulfur monochloride is used. The monochloride generally produces a final product containing the greater amount of sulfur, although in many instances to dichlo-

ride appears to be substantially equivalent to the monochloride.

The product of the first reaction of the polysulfide synthesis is a di(chloro alkyl) sulfide produced by the addition of the elements of the sulfur chloride to the unsaturated carbon atoms of the olefin. This addition reaction is complicated by the ease with which hydrogen chloride is split from the product and by side reactions which form unsaturates, dark and resinous contaminants. The addition products do not generally possess sufficient stability for purification to remove contaminants. Attempts at distillation will destroy it, and even water washing is detrimental. It has accordingly been found that optimum conditions for the preparation of the intermediate include the following:

1. The presence of a stabilizing agent or catalyst premixed with the olefin.

2. The addition of this olefin catalyst to the sulfur halide at a slow uniform rate in keeping with control of the reaction temperature.

3. The maintenance of the temperature of the reaction below about 50° C.

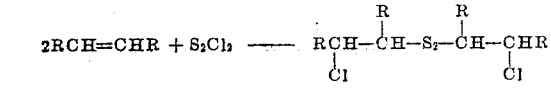
4. The use of an amount of sulfur halide equal to about 0.5 molecule for each double bond in the reactant olefin.

The catalysts or reaction promoters which have been found to be useful in the first step of the polysulfide synthesis include the lower aliphatic alcohols such as methyl-, ethyl-, and propyl alcohols. Of these, ethyl alcohol is preferred, and commercial denatured varieties are satisfactory; the presence of denaturants and water therein are not detrimental. The alcohol is used in minor amounts not to exceed 10 per cent of the olefin and preferably in amounts of from 3 to 5 percent. The alcohol should first be intimately mixed with the olefin and then the alcoholic mixture is reacted with the sulfur halide. The alcohol is ineffective if first mixed with the sulfur halide. This use of catalytic amounts of alcohol results in a marked decrease in hydrogen halide evolution and unreacted components remaining. It is preferred to add the olefin to the halide rather than the reverse to produce a more complete reaction, a minimum hydrogen halide split-out, and a brighter product.

The temperature for the olefin-sulfur halide reaction should not exceed about 50° C. Higher temperatures produce increasing side and secondary reactions, the principal of which is dehydrohalogenation producing halogen deficient products which are of little value in the second step of the polysulfide synthesis. Since the second step involves replacement of the organic halogen substituents with sulfur, it is necessary that the first step reaction temperature be sufficiently low for substantial retention of the halogen, preferably this will be at about 20 to 30° C. Atmospheric pressures are used.

The olefin should be added to the reaction mixture at a rate to permit controlling the temperature in the desired range. The rate of olefin flow, therefore, is primarily determined by the cooling efficiency attainable with a given reactor. It is desirable that the processing time be as short as possible to avoid time-deterioration of products which tend to be unstable. It has been found that a processing time of up to about three hours has been satisfactory, although it is preferred to stay under two hours, as for example from 1 to 1½ hours. Thorough agitation during the reaction should be observed.

The stoichiometry of the foregoing reaction may be represented by the following equation wherein an olefin hydrocarbon generalized by RCH=CHR is reacted with sulfur monochloride, the preferred halide,



A slight excess above the molecular proportion of sulfur chloride shown here may be used when a catalyst is employed.

The foregoing description has dealth fully with the preparation of the chloroalkylsulfide intermediate required in this process. In all cases, this intermediate must be immediately consumed in the process for best results. It is, therefore, freshly prepared and rapidly used without further treatment, since it is not sufficiently stable otherwise. This instability is shown by the readiness with which hydrogen halide splits out therefrom.

The second part of the process is characterized as a condensation reaction whereby the halogen substituent of the intermediate described above is replaced by sulfur. This condensation involves a reaction of the intermediate with an inorganic higher polysulfide.

The preferred conditions for the condensation reaction are as follows:

1. The condensing reagent is a water soluble inorganic higher polysulfide. Examples of these are the alkali metal, ammonium, and alkaline earth metal polysulfides, such as the polysulfides of Na, K, NH_4^+, Ba, and the like. It is preferred to use the sodium polysulfides represented by Na_2S_x, wherein x is at least three, and preferably four, corresponding to the tetrasulfide. Sodium tetrasulfide is preferred for its greater amount of sulfur and is readily available commercially as a 40 per cent aqueous solution. The amount of this reagent required is at least equivalent to the halogen present in the intermediate, or based upon the olefin-raw materials, amounts to not less than one mole for every two moles of double bonds reacted. An excess of about 0.1 mole is usually used.

2. To be effective, the condensation reaction requires the presence of a mutual solvent. Examples are aqueous solutions of organic oxygen compounds, particularly the organic hydroxy compounds and more especially the alcohols such as ethyl and methyl alcohols; ethylene and propylene glycols, and glycerine may also be used. Ethyl alcohol, either pure or denatured, is preferred. When the organic solvent is absent from the reaction, the replacement of halogen from the intermediate by sulfur is so incomplete as to leave about 25 per cent of the halogen in the final product. It has been found that the halogen is substantially replaced by sulfur when the condensation reaction contains alcohol or a like solvent, usually in the proportion of about 1.25 volumes alcohol and one volume water. The proportion of alcohol per volume of water may vary from an effective minimum of about 0.6 to 2 or more volumes of the alcohol.

3. The temperature of the condensation reaction must be at least about 50° C.; otherwise the halogen substituent will not be effectively replaced by sulfur. It is preferred to heat the mixture at a higher temperature, usually at its reflux boiling point, which is about 80° C.

The second part of the process embodying the foregoing requirements for the condensation reaction consists in the following exemplary procedure. An aqueous solution containing 40 per cent of Na_2S_4 by weight is poured into a quantity of a freshly prepared olefin-S_2Cl_2 intermediate. The amount of Na_2S_4 present will be in slight excess, say, about 0.55 gram moles per gram atoms of chlorine in the intermediate. Then the alcohol or like solvent is poured in. Its amount will be not less than about 0.6 volume for each volume of water present in the reaction mixture. As an equivalent alternative, an aqueous alcoholic solution of the sodium polysulfide, separately prepared, may be added to the intermediate. When the reaction mixture thus formed is heated, usually under reflux boiling (around 80° C.), the desired product is formed upon the completion of the condensation reaction. Depending upon the olefin-sulfur halide intermediate, this reaction is completed in about ¼ to 5 hours. Usually, however, about one to three hours is sufficient. Completion of the reaction is evidenced by reduction of organically combined chlorine to less than 1 per cent.

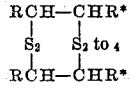
The organic product of the process is then separated

from the condensation reaction mixture by the addition of water. This causes a phase separation forming a layer of the organic sulfur product and an aqueous layer containing by-product sodium halide, excess condensing agent, and much of the alcohol. The oily layer is drawn off and thoroughly washed with water. The product and solvent solution after further water washing is dried and may be freed of any dispersed solids by filtering through diatomaceous earth, clay, or like materials.

A wide variety of dialkylpolysulfide compounds can be produced wherein the ratio of sulfur to the alkyl group in such compounds can be held substantially constant. In the preparation of cutting oil compositions, the molecular concentration of the compound in a given oil base may be kept constant, while the sulfur content of such solution can be varied at will, depending upon the selection of the proper molecular weight olefin with which the sulfur is combined.

Molecular weight determinations of various alkyl polysulfides produced by the above synthesis have shown them to be approximately twice the molecular weight of the olefin used plus the atom weights of the sulfur which have been combined therewith. For example, a product produced from nonene and containing 39.3 weight per cent of sulfur corresponding to 5 atoms of sulfur for 2 moles of the olefin was found to have a molecular weight of 420. This value stands in experimentally good agreement with the theoretical molecular weight of 412. Infrared absorption spectrograms have shown the products to be substantially free from C=C unsaturation.

It is believed from the course of the process reactions and from analytical observations that the compounds produced by reacting olefins with a sulfur halide and an inorganic higher polysulfide are constituted of two saturated hydrocarbon radicals joined together by two sulfur bridges. For example, a theoretical representation of the structure is as follows:



wherein R=a hydrocarbon radical, and R* may be either hydrogen or a hydrocarbon radical.

A satisfactory soluble cutting oil should have a stable sulfur concentration of from about 0.4 to 3 per cent. Usually about 1.25 to 2 per cent sulfur content in the form of an added stable sulfur compound is preferred in soluble oils prepared according to this invention.

The alkyl-polysulfides produced by the above outlined process have an exceptionally high stably combined sulfur content in the range of from 30 to 60 per cent and thus provide an ideal additive, of which relatively small amounts are needed for the desired sulfur level.

The improved cutting oils of this invention are made up by incorporating a sufficient amount of the alkyl polysulfide in a lubricating oil to provide therein the proper sulfur content for the desired extreme pressure characteristics. The water-emulsifiable or soluble cutting oils are produced by incorporating suitable emulsifiers and stabilizers along with alkyl polysulfides in a lubricating oil blend. It is desirable to incorporate an organic chlorine compound to the extent of about 2 per cent chlorine therein in these cutting oil compositions as an antiseize agent. Chlorinated paraffin which is readily available at low cost has been used for this purpose. It is apparent that a wide variety of halogenated organic compounds may be used for this purpose to provide from 0.5 to 5 per cent added chlorine to the concentrate and impart the desired antiseize characteristics to the cutting oil.

The following examples are illustrative of the principles and practice of this invention.

Example I

A nonyl polysulfide was prepared as follows: A five-liter flask equipped with a stirrer, a dropping funnel, and thermometer was charged with 630 grams (5.0 moles) of nonene. Over a period of about 1½ hours 338 grams (2.5 moles) of S_2Cl_2 were added dropwise. The temperature during the addition was maintained between 15 and 28° C., mainly between 15 and 20° C. After all of the S_2Cl_2 had been added, the mixture was stirred for another 1½ hours. To this product was added 1,630 grams (3.75 moles) of 40 per cent Na_2S_4 and 900 ml. of a denatured ethyl alcohol (1 part by volume pure methyl alcohol to 10 parts 190° proof (1 part by volume pure methyl alcohol to 10 parts 190° proof ethyl alcohol). The mixture was heated under reflux for four hours, at which time two liters of water were added. After standing overnight, the two layers were separated and the product layer washed with water. A portion of the material emulsified with the water. This was separated by extraction with pentane. After evaporating the pentane and combining the products, there was obtained 895 grams of a cherry red, slightly viscous product with a sulfur content of 35.6 per cent. This product was incorporated in an extreme pressure soluble cutting oil of the following formulation:

	Percent by weight
Commercial emulsifying base sold under the trademark brand name Solbasene XX and containing about 70 per cent petroleum mahogany sulfonate, about 15 per cent sodium rosin soap, and smaller amounts of diethylene glycol and water	25.0
Nonyl polysulfide produced according to this example	5.6
Commercial chlorinated paraffin wax of about 40 per cent chlorine	5.0
Solvent refined 100 S. S. U. pale process oil	64.4

One object in preparing these formulations was to incorporate approximately 2 per cent added sulfur and 2 per cent added chlorine.

Example II

Nonene-derived polysulfide was made in a semi-commercial operation wherein the nonene charge contained a minor quantity of alcohol to promote its initial reaction with sulfur monochloride. The procedure used is as follows: The equipment consisted of two closed 300-gallon capacity steel reactors operating at atmospheric pressure, and equipped with side entry agitators, internal pipe coils for cooling or heating, reflux condensers, and thermo-couples in the liquid reaction zone. The nonene charging stock consisted of a propylene polymer, boiling range 133–165° C. (272–328° F.). Starting at room temperature, 96 gallons (597 pounds) of nonene and 2 gallons of denatured alcohol (100 parts 190° proof ethyl alcohol and 5 parts of benzene) were mixed together in one of the reactors. Then with tap water running through the cooling coil and while agitating the olefin charge, 23 gallons (330 pounds) of sulfur monochloride (S_2Cl_2) were run in during a time of 2½ hours. The temperature of the reaction rose rapidly to about 50° C. shortly after addition was begun, whereabouts the temperature was maintained by periodically adding solid carbon dioxide into the reacting liquid; a total of 300 pounds was used. The mixture was stirred for 30 minutes after completing the addition of sulfur monochloride. To the intermediate reaction product thus formed there were rapidly added (taking about 10 minutes) 106 gallons (1,185 pounds) of an aqueous solution containing 40 weight per cent sodium tetrasulfide (Na_2S_4) which had previously been prepared by heating and stirring the appropriate amounts of flake sodium sulfide (Na_2S), sulfur, and water. Thereupon, one-half of the mixture was pumped into the second reactor, and 45 gallons denatured alcohol (100 parts 190° proof ethyl alcohol and 5 parts benzene) were added to each half batch mixture. The two mixtures were agitated and heated at 77–83° C. for 3 hours by circulating them through a pipe still. The nonyl polysulfide product was phase separated by add-

ing 75 gallons of water and 50 gallons (374 pounds) of 100 S. S. U. pale oil to each batch and vigorously stirring for 10 minutes. After standing for 2 hours, the aqueous layer was drawn off, and the product layer was drawn into cooling and settling drums where it stood overnight whereupon the product was drawn off from settlings and operations completed by filtering through diatomaceous earth in a Shriver plate and frame press. The weight of the recovered product-oil blend was 1,452 pounds (contains 603 pounds of the pale oil). This product blend was topped to remove 15.5 weight per cent of unreacted nonene and other volatile matter by heating one hour at 90° C. under vacuum (about 5 mm. Hg) to produce the finished product blend containing 18.45 weight per cent sulfur (36.5 per cent S on oil-free basis).

The foregoing topped product blend was incorporated in an extreme pressure soluble cutting oil of the following formulation:

	Percent by weight
Nonyl polysulfide-oil blend (18.45 per cent S)	6.6
Commercial chlorinated wax (40 per cent Cl)	4.4
Commercial glycerol-ester type emulsifier (Emery Industries G–802–R)	18.0
Solvent treated 100 S. S. U. pale oil	71.0
	100.0

The resulting composition has an added organic sulfur and chlorine content of 1.22 per cent and 1.76 per cent, respectively. When made up as a 5 per cent emulsion in water, this product does not stain steel on standing in contact overnight; in machining operations in field tests it gave a superior finish and long cutting tool life.

Example III

A composite batch of several nonyl polysulfide products prepared similarly to the above examples was incorporated into a soluble cutting oil of the following composition:

	Per cent
Solbasene XX	25.0
Nonyl polysulfide (33.1% S)	3.77
Chlorinated paraffin wax (40% Cl)	4.40
Solvent refined mineral 100 S. S. U. pale oil	66.83

This formulation has an added sulfur content of 1.25 per cent and chlorine content of 1.75 per cent. Timken tests on this material gave a seizure load of 22.5 pounds in comparison with 5 pounds on a commercial nonextreme pressure type soluble oil (essentially 100 S. S. U. pale oil containing 17.5 per cent Solbasene XX).

It has been discovered that the use of the high sulfur containing compounds of this invention in soluble cutting oils produces an end product having equivalent or better extreme pressure properties with much smaller quantities of sulfur bearing material with resulting economies, and at the same time considerably less emulsifying material is required to obtain satisfactory stable emulsions with a further major reduction in cost. This is illustrated in the following typical formulations:

Example IV

A soluble cutting oil representative of this invention using a petroleum sulfonate type emulsifier is as follows:

	Percent by weight
Petroleum mahogany sulfonate	16.00
Sodium rosin soap	4.55
Diethylene glycol	1.00
Water	1.20
Alkyl polysulfide (39.86% S)	3.07
Chlorinated paraffin wax (40% Cl)	3.42
Mineral oil	70.76

A comparative composition representative of the prior art is as follows:

	Percent by weight
Petroleum mahogany sulfonate	23.00
Sodium rosin soap	7.20
Diethylene glycol	1.20
Water	1.70
Sulfurized lard oil (10% S)	12.50
Chlorinated paraffin wax (40% Cl)	4.00
Mineral oil	50.00

The economies resulting from the high sulfur materials characteristic of this invention over the sulfur-containing agents of the prior art are readily apparent. Another advantage for the composition of this invention in the soluble type extreme pressure cutting oils resulting from the reduction in the amount of emulsifying agent exists in maintaining the presence of a substantially greater proportion of mineral lubricating oil in contact with the worked metal surfaces.

Example V

A soluble cutting oil representative of this invention but using an ester type emulsifier is as follows:

	Percent by weight
Potassium resinate soap	9.00
Glyceryl mono-oleate	6.80
Red oil soap	1.00
Water	1.20
Alkyl polysulfide (39.86% S)	3.45
Chlorinated paraffin wax (40% Cl)	4.40
Mineral oil	74.15

A comparative prior art composition would contain the following:

	Percent by weight
Potassium resinate soap	14.00
Glyceryl mono-oleate	10.25
Red oil soap	1.50
Water	2.25
Sulfurized fatty oil	12.50
Chlorinated paraffin wax	4.40
Mineral oil	55.10

It will be apparent that other emulsifying agents may be employed than those shown in the specific examples. The necessary property of this material is that it renders the oil readily dispersible or emulsifiable with water. Any suitable agent for preparing emulsions of oil and water may be used which is not objectionably corrosive to metal surfaces. In addition to those cited, examples of such emulsifying agents include naphthenic acid soaps such as those derived from petroleum crudes containing naphthenic acids, sulfonated naphthenic acids such as those obtained by treating naphthenic base oils with strong or fuming sulfuric acid followed by the recovery from the oil of the resulting mixture of organic acids, also the ordinary fatty oil soaps of fatty acids with suitable metals, preferably sodium and potassium and ammonium soaps, and also similar soaps of wax acids, i. e., acids obtained by the limited oxidation of paraffin wax at low temperatures. The amount of emulsifying agent used will vary depending upon its effectiveness in emulsifying the oil in water and upon the concentration of the finished emulsion. For most emulsifying agents and for the concentrations ordinarily contemplated for use as a cutting and cooling composition, from about 10 to 40 per cent by weight of the emulsifying material will be used in the soluble cutting oil composition.

The lubricating oil constituent may be any good grade of hydrocarbon lubricating oil commonly used for the purpose. Although in some of the examples an oil of 100 viscosity Saybolt Universal is specified, any oil such as is commonly used for making cutting oils, for example, one having a viscosity between about 50 and 200 Saybolt seconds at 100° F. may be used.

Small quantities of silicone polymer antifoaming

agents may also desirably be used in the various formulations.

The soluble cutting oil compositions of this invention will ordinarily be used with about 2 to about 100 volumes of water to one volume of the sulfur-containing soluble oil.

From the foregoing examples, it is evident that many modifications and variations of the invention as hereinbefore set forth may be made without departing from the spirit and scope thereof. The examples are given for purposes of illustration without intended limitations of the invention which is limited only by the terms of the appended claims.

We claim:

1. An improved soluble cutting oil adapted for emulsification with water in the proportion of one volume of soluble oil to from 2 to 100 volumes of water to form a cutting and cooling composition, said soluble oil consisting essentially of a major proportion of a hydrocarbon oil of cutting oil viscosity and minor amounts of an emulsifying agent, a chlorine-containing antiseize agent, and a high sulfur content olefin-derived polysulfide extreme pressure agent prepared by first reacting a nonconjugated olefinic hydrocarbon having from at least 6 to about 30 carbon atoms with about a stoichiometric equivalent of sulfur chloride at a temperature of from about 0 to about 50° C. for a time sufficient to form a di(chloro alkyl)sulfide intermediate but not to exceed about 3 hours in the presence of a water-soluble aliphatic alcohol and then at once condensing said intermediate with a water-soluble inorganic higher polysulfide at about 50 to 100° C. in a mutual solvent for a time not to exceed about four hours, the emulsifying agent being present in amounts between about 10 and 40 per cent sufficient to form a stable emulsion, the antiseize agent being present in amounts sufficient to impart about 2 per cent added chlorine to the oil, and the olefin-derived polysulfide being present in amounts sufficient to impart from 1.25 to 2 per cent added sulfur to the soluble oil.

2. An improved soluble cutting oil composition consisting essentially of a major proportion of a hydrocarbon oil of cutting oil viscosity and minor amounts of an emulsifying agent, a chlorine-containing antiseize agent, and an extreme pressure agent containing from 30 to 60 per cent sulfur wherein said extreme pressure agent is prepared by first reacting a nonconjugated olefinic hydrocarbon having from at least 6 to about 30 carbon atoms with about a stoichiometric equivalent of sulfur chloride at a temperature from about 0 to about 50° C. for a time sufficient to form a di(chloro alkyl)sulfide intermediate but not to exceed about 3 hours in the presence of a water-soluble aliphatic alcohol and then at once condensing said intermediate with a water-soluble inorganic higher polysulfide at a temperature of from about 50 to about 100° C. in a mutual solvent for a period not to exceed about four hours, the emulsifying agent being present in an amount varying between about 10 and 40 per cent, the antiseize agent being present in an amount sufficient to impart about .5 to 5 per cent added chlorine to the oil and the extreme pressure agent being present in an amount sufficient to impart from about .4 to 3 per cent added sulfur to the soluble oil.

3. An improved soluble cutting oil adapted for emulsification with water to form a cutting and cooling composition, said soluble oil consisting essentially of a major proportion of a hydrocarbon oil of cutting oil viscosity and minor amounts of an emulsifying agent, a chlorine-containing antiseize agent, and an extreme pressure agent containing from 30 to 60 per cent sulfur wherein said extreme pressure agent is prepared by first reacting a nonconjugated olefinic hydrocarbon having from at least 6 to about 30 carbon atoms with about a stoichiometric equivalent of sulfur chloride at a temperature from about 0 to about 50° C. for a time sufficient to form a di(chloro alkyl) sulfide intermediate but not to exceed about 3 hours in the presence of a water-soluble aliphatic alcohol and then at once condensing said intermediate with a water-soluble inorganic higher polysulfide at a temperature of from about 50 to about 100° C. in a mutual solvent for a period not to exceed about four hours, the emulsifying agent being present in amounts between about 10 and 40 per cent, the antiseize agent being present in amounts sufficient to impart about .5 to 5 per cent added chlorine to the oil and the extreme pressure agent being present in an amount sufficient to impart from about .4 to 3 per cent added sulfur to the soluble oil.

4. An improved soluble cutting oil adapted for emulsification with water to form a cutting and cooling composition, said soluble oil consisting essentially of a major proportion of a hydrocarbon oil of cutting oil viscosity and minor amounts of an emulsifying agent, a chlorine-containing antiseize agent, and an extreme pressure agent containing from 30 to 60 per cet sulfur wherein said extreme pressure agent is prepared by first reacting a nonconjugated olefinic hydrocarbon having from at least 6 to about 30 carbon atoms with about a stoichiometric equivalent of sulfur chloride at a temperature from about 0 to about 50° C. for a time sufficient to form a di(chloro alkyl) sulfide intermediate but not to exceed about 3 hours in the presence of a water-soluble aliphatic alcohol and then at once condensing said intermediate with a water-soluble inorganic higher polysulfide at a temperature of from about 50 to about 100° C. in a mutual solvent for a period not to exceed about four hours, the emulsifying agent being present in amounts between about 10 and 40 per cent, the antiseize agent being present in amounts sufficient to impart about .5 to 5 per cent added chlorine to the oil and the extreme pressure agent being present in an amount sufficient to impart from about 1.25 to 2 per cent added sulfur to the soluble oil.

5. An improved soluble cutting oil adapted for emulsification with water to form a cutting and cooling composition, said soluble oil consisting essentially of a major proportion of a hydrocarbon oil of cutting oil viscosity and minor amounts of an emulsifying agent, a chlorine-containing antiseize agent, and an extreme pressure agent containing from 30 to 60 per cent sulfur wherein said extreme pressure agent is prepared by first reacting a nonconjugated olefinic hydrocarbon having from at least 6 to about 30 carbon atoms with about a stoichiometric equivalent of sulfur chloride at a temperature from about 0 to about 50° C. for a time sufficient to form a di(chloro alkyl) sulfide intermediate but not to exceed about 3 hours in the presence of a water-soluble aliphatic alcohol and then at once condensing said intermediate with a water-soluble inorganic higher polysulfide at a temperature of from about 50 to about 100° C. in a mutual solvent for a period not to exceed about four hours, the emulsifying agent being present in amounts between about 10 and 40 per cent, the antiseize agent being present in amounts sufficient to impart about 2 per cent added chlorine to the oil and the extreme pressure agent being present in an amount sufficient to impart from about .4 to 3 per cent added sulfur to the soluble oil.

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