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HYDRAULIC FLUID

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This invention relates to fluid compositions and particularly to fluids for use in hydraulic machinery for transmission of power, such as shock absorbers, brake mechanisms, artillery recoil mechanisms, lifting jacks, door checks, etc.

While mechanisms of this class differ in details of construction, their operation involves similar principles and they also present common practice problems by reason of similarity of operating parts and conditions of use. Metal cylinders and rubber cups or washers are common to most commercial devices of the class and one of the important practical problems is that of providing a fluid, for use therein, which will not produce corrosion of metal and deterioration of rubber.

Various compositions including one or more of vegetable, animal, and mineral oils, alcohols, ethers, etc. have been prepared and used with varying degrees of success but, so far as I am aware, no present commercial fluid satisfactorily meets the aforementioned requirements.

I have found that the desired freedom from metal corroding and rubber deteriorating properties is possessed to a surprising degree by a class of substances not heretofore employed in hydraulic fluids, viz. a specific class of esters of acids, derivable from vegetable and animal oils preferably containing olefinic linkages and/or hydroxyl groups, such as the acids present, in free state or as esters, in such oils as: almond, blackfish, candle-nut, castor, China-wood, cocoanut, cod, corn, cottonseed, croton, eucalyptus, geranium, grape seed, hemp, juniper, lard, lemon, linseed, maize, menhaden, neat's foot, olive, orange, palm, peanut, pine, porpoise, rape seed, seal, sesame, shark, sperm, tallow, train, sunflower, tung, turpentine, walnut, whale, wool, and the like. The foregoing class of substances has also the important property of leaving upon metal surfaces of operating parts a thin protective film, which reduces metal corrosion to a substantial degree.

The esters of the foregoing derivation which are comprised in my invention are the mono-esters of mono- and di- or triatomic alcohols and the mono- or diesters of di- or triatomic alcohols such as the mono- and diglycol and glyceryl esters, the alcohol having, preferably, not more than five carbon atoms per molecule.

More specifically and preferably however, I utilize the mono- and diglycerides and glycolides of vegetable oils such as the mono- or diglycerides or glycolides of soya bean oil acids or the mono- and diglycerides or glycolides of castor oil

acids, i. e., glycol or glyceryl mono- and diricinoleates.

To provide properties of fluidity desirable where extremes of temperature are encountered, the esters referred to such as the glyceryl and glycol mono- and diesters, may advantageously be admixed with one or more solvents or diluents, preferably organic, of low freezing point. For this purpose I may use: alcohols, such as the mono- and polyhydric, aliphatic, alicyclic, aromatic and amino alcohols, such as methanol, propanol, isobutanol, octanol, diacetone alcohol, ethylene and propylene glycol, glycerol, sorbitol, cyclohexanol, phenol, benzyl alcohol, triethanolamine and ethoxyaminobutanol; organic esters such as ethyl and butyl acetate; ethers such as diisobutyl, ethyl tertiary butyl and methyl ricinoleyl ethers; alcohol ethers, such as ethylene glycolmonoethyl ether and diethyleneglycolmonoethyl ether; aldehydes such as heptaldehyde and benzaldehyde; ketones, such as diisopropyl ketone and cyclohexanone; nitrogen-containing compounds such as triethanolamine, octyl amine, tetrahydrofurfuryl alcohol and furane compounds; hydrocarbons, such as isooctane, benzene, and cyclohexane.

Solvents or diluents as above illustrated may be used in ratios to the ester which vary over a wide range, although, generally speaking, I prefer to have at least about 10% of the ester present in the final composition.

As examples of representative hydraulic fluids of this invention. I have found that the following compositions have highly desirable characteristics:

Example 1

	Percent by volume
Isobutanol	75
Glyceryl monoricinoleate	25

Example 2

	Percent by volume
Isobutanol	56.25
Glycerine	13.5
Propylene glycol	20.5
Glyceryl monoricinoleate	10.00

Example 3

	Percent by volume
Isobutanol	62.5
Diethylene glycol	22.5
Water	15.0

To 80 parts of the above mixture was added 20 parts glyceryl monoricinoleate.

Example 4

	Percent by volume
Isobutanol	56.25
Diethylene glycol	20.25
Water	13.5
Glyceryl monoricinoleate	10.0

Example 5

	Percent by volume
Diacetone alcohol	50
Glyceryl monoricinoleate	50

Example 6

	Percent by volume
Ethyl alcohol	50
Glyceryl monoricinoleate	50

Example 7

	Percent by volume
Ethyleneglycolmonoethyl ether	65
Glyceryl monoricinoleate	35

Example 8

The glyceryl monoricinoleate of Examples 1-7 inclusive, may be replaced by a like amount of glyceryl diester of ricinoleic acid, or of the mixture of oleic, linoleic and palmitic acids obtainable from soya bean oil.

Example 9

	Percent by volume
Branched chain aliphatic alcohols (obtained by pressure catalytic hydrogenation of carbon oxide) boiling 147-157° C.	50
Soya bean oil monoglyceride	50

Example 10

	Per cent by volume
Branched chain aliphatic alcohols (obtained by pressure catalytic hydrogenation of carbon oxide) boiling 147-157° C.	50
Soya bean oil diglyceride	50

Example 11

As an example only, typical of the procedure, which may be followed in the case of any alcoholic body-oil mixture according to this invention, 15 parts by volume of castor oil and 32 parts propylene glycol are heated, using a concentration of approximately 4% potassium oleate as a catalyst, at 180-200° C., for a time sufficient for all the original oil to react completely. Whether or not all the oil has reacted may be readily determined, for example, by utilizing the fluid as an electrical resistance and noting when no further change in said resistance takes place. At that point it will be found that all the oil has reacted with the alcohol or alcoholic body. I have found that from ¼ to 2 hours heating is sufficient and that from 1-2 hours is preferable. I may use this product as such but prefer to mix it with an equal volume of butyl alcohol (normal or iso).

The product resulting from the heat treatment comprising substantially propylene glycol monoricinoleate is mixed to the extent of 47 parts by volume with 53 parts isobutanol or normal butanol to give a complete hydraulic fluid of highly desirable characteristics.

Example 12

24.3 parts by volume of castor oil and 32 parts by volume of ethylene glycol are heated at 170-190° C., while using as a catalyst a concentration of approximately 2% lead oxide by weight. The

mixture is heated for a length of time sufficient for all the castor oil to react completely. Complete reaction takes place after heating from 1-2 hours and may be determined, if desired, in a manner such as set forth in Example 11. The final product, which comprises substantially ethylene glycol monoricinoleate, is admirably suited for use in hydraulic apparatus, but preferably I mix it in the ratio of 47 parts by volume with 53 parts by volume of isobutanol.

Example 13

14.5 parts by volume of castor oil and 32 parts by volume of propylene glycol are heated at 150-175° C., 4% by weight of potassium oleate being used as a catalyst, for 1-2 hours. At the expiration of the heating all the castor oil has completely reacted with the glycol (which may be determined as set forth in Example 11) to give a fluid comprising a greater part propylene glycol monoricinoleate which is, by itself, well adapted for use with hydraulically operated apparatus. I prefer, however, to mix equal volumes of normal butanol with the final product.

Example 14

24.3 parts by volume of grape seed oil and 32 parts by volume of ethylene glycol are heated at 170-190° C., while using as a catalyst a concentration of approximately 2% lead oxide by weight. The mixture is heated for a length of time sufficient for all the grape seed oil to react completely. Complete reaction takes place after heating from 1-2 hours and may be determined, if desired, in a manner such as set forth in Example 11. The final product, which comprises the greater part ethylene glycol monooleate and linoleate, is admirably suited for hydraulic apparatus but, preferably, I mix it in the ratio of 47 parts by volume with 53 parts by volume of isobutanol.

Hydraulic fluids are used under a wide range of climatic and artificial conditions involving a considerable range of temperature, pressure, and the like. For example, such fluids when used in automotive mechanisms operate at temperatures that may vary from -50° F. to above 150° F. This, in turn, requires fluidity at low temperatures and at the same time sufficient viscosity to permit operation at high temperatures.

In order to comply with all these requirements I have found that in the case of certain individual diluents it may be desirable to add a solubilizing agent to the ester-diluent mixture, and in such cases I have found that various materials or combinations of materials are suitable. Thus, for example, such compounds as alkyl ricinoleates, e. g. ricinoleyl hydroxy stearate, glycol stearate and octyl-2 methyl pentyl ricinoleate, or the higher, branched chain alcohols obtainable by the catalytic hydrogenation of oxide of carbon, such as 2-5 dimethyl octanol-1, 4-7 dimethyl pentanol-2, and the like, are effective as solubilizers.

Another method of solubilization according to this invention is accomplished by the use of emulsifying agents which produce permanent minutely divided two phase systems, e. g. by the use of cellulose ethers, methyl or ethyl cellulose, glycol cellulose, polyalcohol derivatives, such as glycol stearate, alcoholic amines such as ethanol amines, and the like.

The lubricating qualities of the hydraulic fluids of this invention may be even further improved by the addition of assisting lubricants, such as deflocculated graphite, or extreme pressure lu-

bricants, such as lorol phosphate, lorol nitrate, tricresyl phosphate, ricinoleyl phosphate, and the like; metal soaps such as potassium oleate, and the like.

These assisting lubricants have a particularly advantageous value in lowering the pour point at temperatures slightly above that at which the lubricant solidifies.

In like manner as the lubricating qualities of the fluids of this invention may be improved, corrosion of the operating parts with which the fluids come in contact, if ordinarily occurring, may be overcome by use of corrosion inhibitors, without adversely affecting the advantageous characteristics of my fluid. Various materials may be utilized for inhibition of corrosion which, in some instances, also fill the role of assisting lubricants, such as above described, and/or other additional functions. Thus, for example, I may utilize alkali metal oleates, ricinoleates, abietates, arsenites, benzoates, phosphates, chromates, isopropyl sulfonates, dichromates, nitrites, di- or triethanol amines, glucamines, sulfurated castor oil, sulfonic acid salts of oleic acid, Gardinols, and the like as corrosion inhibitors.

The proportion of corrosion inhibitor to the hydraulic fluid proper may be widely varied, particularly if it is also acting to fulfill other functions, such, for example, as those of an assisting lubricant. I prefer, however, to utilize the corrosion inhibitor in relatively small quantities such as not greatly exceeding, say, 0.2-5% of the total composition.

In order to obtain a fluid, such as previously described, which possesses sufficient body at the extremes of temperature that may be encountered in automotive operation, it is sometimes desirable, in preparing the fluid, to add materials as bodying agents, such as metal stearates, particularly aluminum, calcium and magnesium stearates, cellulose compounds, such as masticated cellulose, glycol cellulose, and methyl cellulose, gum tragacanth, cyclohexanolamine stearates, alginic acid salts, and the like.

Similarly materials may be added, which depress the pour point of the fluid, such as octadecenediol ether, molasses, glucose, sorbital, the suspensions of graphite in castor oil, known under the trade-marked name "Castordag," suspensions of graphite in water known under the trade-marked name of "Aquadag," suspensions of graphite in glycerine known under the trade-marked name of "Glydag," and the like.

Although the fluids of this invention are not reactive toward oxidizing or gumming agents under normal conditions of use, nevertheless for extremely severe oxidizing conditions, the addi-

tion of minute quantities of anti-oxidants or phenolic bodies tend to inhibit even incipient oxidation and gumming. Such bodies are illustrated by phenols, such as 3, 4, 5-triaminophenol, para-aminophenol, pyrogallol and amines such as 2, 4-diamino-4-hydroxy diphenyl amine, paraaminodiphenyl amine, phenyl alphanaphthylamine, diphenylamine, and the like.

Various changes may be made in the present invention without departing therefrom or sacrificing any of the advantages thereof.

I claim:

1. A fluid for use in fluid pressure apparatus, including at least 10% of a substance from the group consisting of glyceryl mono- and diesters of vegetable and animal oil acids and glycol esters of said acids, together with a liquid aliphatic monohydric alcohol and a liquid aliphatic polyhydric alcohol.
2. A fluid for use in fluid pressure apparatus, including at least 10% of a substance from the group consisting of: glyceryl mono- and diesters of vegetable and animal oil acids and glycol esters of said acids, together with isobutanol and a glycol.
3. A fluid for use in fluid pressure apparatus, including at least 10% of a substance from the group consisting of: glyceryl mono- and diesters of vegetable and animal oil acids and glycol esters of said acids, together with isobutanol and propylene glycol.
4. A fluid for use in fluid pressure apparatus, including at least 10% of glyceryl monoricinoleate, together with appreciable amounts of glycerine, propylene glycol and isobutanol.
5. A fluid for use in fluid pressure apparatus including at least 50% by volume of a liquid monohydric alcohol, at least 20.25% of a liquid aliphatic polyhydric alcohol and at least 10% of a substance selected from the group consisting of glyceryl mono- and di-esters of vegetable and animal oil acids.
6. A fluid for use in fluid pressure apparatus including at least 50% by volume of a liquid aliphatic monohydric alcohol, at least 20.25% of a liquid glycol, and at least 10% of glyceryl monoricinoleate.
7. A fluid for use in fluid pressure apparatus including at least 50% by volume of a liquid aliphatic monohydric alcohol, at least 20.25% of a liquid glycol, and at least 10% of glyceryl diricinoleate.
8. A fluid for use in fluid pressure apparatus including at least 10% of a glycol monoricinoleate together with appreciable amounts of a glycol and a liquid aliphatic monohydric alcohol.

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