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HYDRAULIC FLUIDS

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4 Claims

ABSTRACT OF THE DISCLOSURE

Petroleum based hydraulic fluids, when contaminated with sea water form tight sea water-in-oil emulsions and protect hydraulic systems, consist of petroleum lubricating oil having a viscosity of about 60-920 SSU at 100° F. and contain in combination (a) about 4-8 volume percent of a mineral oil solution of about 35-45 weight percent of the condensation product of (i) 1 mole of a monoalkylphenol wherein the alkyl group has about 90-120 carbon atoms, (ii) 1 mole of tetraethylenepentaamine, and (iii) 2 moles of formaldehyde, said solution containing about 1.0-1.5 percent nitrogen; (b) zero to about 0.5 volume percent of polyoxyethylene lauryl alcohol having about four oxyethylene groups; (c) about 1.5-1.7 volume percent of a mineral oil solution of about 40-45 weight percent calcium sulfonate, said solution having a total base number of about 15-30; (d) about 0.25-0.35 volume percent of 2,6-di-(t-butyl)-paracresol; (e) about 0.035-0.045 volume percent of bis-(octyldithio)-thiadiazole; (f) zero to about 0.7 volume percent of paraffin wax-naphthalene condensation product; (g) about 0.1-0.4 volume percent of a methylnaphthalene solution of about 4.8 weight percent of N,N'-dimethyldithiooxamide; and (h) about 3-5 parts per million of silicone oil foam depressant having a viscosity of about 1000 cs. at 25° C., such fluids have a viscosity of about 12-220 cs. at 100° F.

The invention hereindescribed was made in the course of or under a contract with the Department of the Navy.

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of copending application, Ser. No. 682,651, filed Nov. 13, 1967, now abandoned.

BACKGROUND OF THE INVENTION

The present invention pertains to petroleum oils containing additives that are used as hydraulic fluids in numerous hydraulic power applications in ships and submarines. Gross contamination of the fluids with sea water may occur. Therefore, protection of the hydraulic systems and fluids against deterioration is required. The fluids must form tight sea water-in-oil emulsions, provide hydrolytic stability, antiwear, antirust, anticorrosion, oxidation stability, and continue performance as a power transmission fluid, when so contaminated, as specified in MIL-L-17672D.

Known compounded petroleum oils used as hydraulic fluids were unsatisfactory in their ability to form tight sea water-in-oil emulsions or were hydrolytically unstable so that damage to the hydraulic systems occurred.

SUMMARY

The hydraulic fluids of the invention consist of a petroleum lubricating oil containing a unique combination of additives that are stable against hydrolysis at elevated temperatures occurring during use of the fluid, compatible with sea water to minimize salt precipitation, and overcome corrosive effects resulting from the aqueous ionic

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mixtures that form from salt water contamination. The additive combination further provides maximum protection against corrosion of bronze parts in the hydraulic system, minimal effect upon rubber seals, and produces tight sea water-in-oil emulsions (i.e. no free water shall separate after 24 hours at 130° F.) for continued performance of the fluid after contamination. The viscosity of the fluid is dependent upon the specific power transmission requirement, and is generally in the range of about 12-220 cs. at 100° F.

Hydraulic fluids, having a viscosity of about 12-220 cs. at 100° F., of the invention consist of the following ingredients:

- (a) About 4-8 volume percent of a mineral oil solution of about 35-45 weight percent of the condensation product of (i) 1 mole of a monoalkylphenol wherein the alkyl group has about 90-120 carbon atoms, (ii) 1 mole of tetraethylenepentaamine, and (iii) 2 moles of formaldehyde, said solution containing about 1.0-1.5 percent nitrogen;
- (b) Zero to about 0.5 volume percent of polyoxyethylene lauryl alcohol having about four oxyethylene groups;
- (c) About 1.5-1.7 volume percent of a mineral oil solution of about 40-45 weight percent calcium sulfonate, said solution having a total base number of about 15-30;
- (d) About 0.25-0.35 volume percent of 2,6-di-(t-butyl)-paracresol;
- (e) About 0.035-0.045 volume percent of bis-(octyldithio)-thiadiazole;
- (f) Zero to about 0.7 volume percent of paraffin wax-naphthalene condensation product;
- (g) About 0.1-0.4 volume percent of a methylnaphthalene solution of about 4.8 weight percent of N,N'-dimethyldithiooxamide;
- (h) About 3-5 parts by million of silicone oil foam depressant having a viscosity of about 1000 cs. at 25° C; and
- (i) The balance a petroleum lubricating oil having a viscosity of about 60-920 SSU at 100° F.

Petroleum lubricating oils suitable for use in the hydraulic fluids of the invention are highly refined and stable commercially available oils having viscosities in the range of about 60 SSU (about 10 cs.) to about 920 SSU (about 198 cs.) at 100° F. Selection and blending of the appropriate base oil(s) is readily determined by the desired functional viscosity of the hydraulic fluid.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The composition of exemplary low viscosity and high viscosity sea water compatible hydraulic fluids is set forth in Table I wherein the components are as identified above.

TABLE I.—COMPOSITION OF SEA WATER COMPATIBLE HYDRAULIC OILS

Component:	Composition, volume percent	
	Low viscosity fluid	High viscosity fluid
a.....	5.9±0.3	5.9±0.3
b.....	0.20±0.02	0.20±0.02
c.....	1.60±0.1	1.60±0.1
d.....	0.30±0.02	0.30±0.02
e.....	0.04±0.004	0.04±0.004
f.....	0.60±0.05	0.60±0.05
g.....	0.2±0.02	0.2±0.02
h.....	14 p.p.m. ±1	14 p.p.m. ±1
i.....	(2)	(2)

¹ Parts per million instead of volume percent.

² Balance.

The base petroleum lubricating oil, having a viscosity of about 125-140 SSU at 100° F., used for the low viscosity fluid was a mixture of about 14 volume percent of an acid treated and clayed naphthenic transformer oil and about 86 volume percent of a solvent extracted, de-

waxed, and hydrogenated SAE-10 Midcontinent oil. For the high viscosity fluid the base petroleum oil was 100 volume percent of a solvent extracted, dewaxed, hydrogenated and clayed SAE-20 Midcontinent oil having a viscosity of about 360-390 SSU at 100° F.

Component (a) of the hydraulic fluids of the invention is a mineral oil (SAE-5 grade) solution containing about 1.1-1.3 percent nitrogen and about 35-45 weight percent of the condensation product obtained by reacting (i) 1 mole of a monoalkylphenol wherein the alkyl group has about 90-120 carbon atoms, (ii) 1 mole of tetraethylenepentaamine, and (iii) 2 moles of formaldehyde, in the mineral oil solvent at a temperature of 310-320° F. for about 4 hours while continuously passing nitrogen through the mixture to remove water of reaction. The reaction mixture is filtered to remove any unreacted material and the filtrate adjusted by the addition of solvent oil to the appropriate nitrogen and weight contents. The alkylphenol is produced by conventional BF₃ technique of alkylating phenol with a butylene polymer containing about 130-140 carbon atoms. Such alkylation is well known to the art and need not be further described.

The chemical and physical properties of the exemplary fluids as well as the MIL-L-17672D specifications therefor are set forth in Table II.

We claim:

1. A hydraulic fluid consisting of:

- (a) about 4-8 volume percent of a mineral oil solution of about 35-45 weight percent of the condensation product of (i) 1 mol of a monoalkylphenol wherein the alkyl group has about 90-120 carbon atoms, (ii) 1 mol of tetraethylenepentaamine, and (iii) 2 mols of formaldehyde, said solution containing about 1.0-1.5 percent nitrogen;
- (b) zero to about 0.5 volume percent of polyoxyethylene lauryl alcohol having about four oxyethylene groups;
- (c) about 1.5-1.7 volume percent of a mineral oil solution of about 40-45 weight percent calcium sulfonate, said solution having a total base number of about 15-30;
- (d) about 0.25-0.35 volume percent of 2,6-di-(t-butyl)-paracresol;
- (e) about 0.035-0.045 volume percent of bis-(octyldithio)-thiadiazole;
- (f) zero to about 0.7 volume percent of paraffin wax-naphthalene condensation product;
- (g) about 0.1-0.4 volume percent of a methylnaphthalene solution of about 4.8 weight percent of N,N'-dimethyldithiooxamide;
- (h) about 3-5 parts by million of silicone oil foam

TABLE II

Property or test	(MS-2110TH type)		(MS-2190 TEP type)		Test method number (Fed. std. 791)
	Low viscosity fluid	Specification	High viscosity fluid	Specification	
Pour point, F.	-35	-10 max.	5	20 max.	201
Flash point, F.	390	325 min.	475	350 min.	1,103
Viscosity, cs. at 100° F.	44.0	37-45	107.4	82-110	
Viscosity, cs. at 210° F.	6.4	5.6 min.	11.3	8.2 min.	305
Viscosity, cs. at 0° F.	2,500	3,600 max.			
Corrosion, copper strip, 212° F.	1B	1 max.	1B	1 max.	5,325
Rust prevention, sea water present.	Pass	Pass	Pass	Pass	
Emulsion, sea water, 130° F.					3,201
After 24 hours:					
Water separation, vol. percent.	0	0	0	0	
Oil separation, vol. percent.	2.5	5 max.	3.1	5 max.	
Oxidation test, hours required to reach 2.0 neutralization number.	(1)	720 min.	(1)	720 min.	(2)
Insoluble sludge, mg.	44.4	100 max.	39.1	100 max.	
Saponification number	0.2	3.0 max.	0.5	3.0 max.	5,401
Sulfur, wt. percent.	0.12	0.75 max.	0.13	0.75 max.	5,202
Pump test, average wt. loss mg.:					
Steel gears	5.15	30 max.	5.1	30 max.	
Bronze bushings	14.5	15 max.	20.0	15 max.	
Corrosion, weight loss, mg./cm. ²					5,308
Aluminum	0.011	0.2 max.	0.000	0.2 max.	
Steel	0.000	0.2 max.	0.015	0.2 max.	
Galvanized steel	0.015	0.2 max.	0.023	0.2 max.	
Copper	0.008	0.2 max.	0.004	0.2 max.	
Silver Alloy	0.004	0.2 max.	0.004	0.2 max.	
Buna-N rubber, percent volume change with respect to reference fluid furnished by Government.	+3.3	±5 max.	+0.9	±5 max.	3,606

¹ Over 720.

² ASTM D-943.

The pump test is used to ascertain protection against corrosion of steel and bronze metal parts in contact with sea water contaminated fluids. In this test, one gallon of fluid plus 375 ml. of synthetic sea water (ASTM Method F 665) is continuously circulated from a reservoir through a Pescos IP 349 P4 hydraulic pump, having steel gears and bronze bushings mated by previous operation, under controlled temperature conditions for 50 hours with the pump operating at 1000±50 p.s.i.g., 3600±50 r.p.m., at a flow rate of 3.3±0.3 g.p.m., and pump inlet temperature of 140±5° F. At the end of the test the two steel gears and four bronze bushings are removed and weighed to determine average weight loss of the parts, which weight loss is indicative of the corrosivity of the contaminated fluid.

It has been found that each of the enumerated additives, in the amounts recited, is essential for the production of petroleum base hydraulic fluids that will properly perform when contaminated with sea water and not be deleterious to the hydraulic system in which they are used.

depressant having a viscosity of about 100 cs. at 25° C.; and

(i) the balance a petroleum lubricating oil having a viscosity of about 60-920 SSU at 100° F.;

60 said fluid having a viscosity of about 12-220 cs. at 100° F.

2. The fluid of claim 1 wherein said petroleum lubricating oil has a viscosity of about 100-400 SSU at 100° F.

3. The fluid of claim 1 having a viscosity of about 37-45 cs. at 100° F. wherein

(a) is about 5.6-6.2 volume percent;

(b) is about 0.2 volume percent;

(d) is about 0.3 volume percent;

(e) is about 0.04 volume percent;

(f) is about 0.6 volume percent;

(g) is about 0.2 volume percent;

(h) is 4 p.p.m.; and

(i) is a petroleum lubricating oil having a viscosity of about 125-140 SSU at 100° F.

4. The fluid of claim 1 having a viscosity of about 75 82-110 cs. at 100° F. wherein

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- (a) is about 5.6–6.2 volume percent;
- (b) is zero;
- (d) is about 0.3 volume percent;
- (e) is about 0.04 volume percent;
- (f) is zero;
- (g) is about 0.2 volume percent;
- (h) is 4 p.p.m.; and
- (i) is a petroleum lubricating oil having a viscosity of about 360–390 SSU at 100° F.

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5 JOHN D. WELSH, Primary Examiner
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