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HYDRAULIC TRANSMISSION FLUID

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The present invention relates to improvements in hydraulic transmission fluids and more generally to lubricating compositions having superior anti-friction properties. The invention relates particularly to power transmitting and lubricating compositions designed for use in hydraulic transmissions of modern automotive vehicles.

In the prior art numerous compositions have been proposed for use in torque converters, fluid clutches, semi-automatic and fully automatic automotive transmissions and the like and in some cases difficulty has been encountered in meeting certain specific requirements. This is not surprising when it is considered that for many types of such automatic transmissions the fluid must act not only as a power transmission medium but in addition must provide satisfactory lubrication, act as a hydraulic control fluid, and perform as a heat transfer medium. The fluid must also be free from corrosive effects and objectionable odors. Moreover, the fluid must be so designed as to function properly over a wide temperature range and it must possess a high level of oxidation resistance and a good degree of detergency. The latter properties are extremely important, since even small quantities of sludge and other oxidation products, if allowed to settle out, can easily clog the very small orifices in the hydraulic control system and cause serious malfunctioning and damage to the transmission.

Although many of the numerous compositions of hydraulic transmission fluids hereinbefore referred to have been satisfactory with regard to most of the requirements as set forth above, to date no product has been found that is entirely satisfactory with respect to its anti-friction properties. In one popular type of torque converter transmission, for example, under certain operating conditions there is sliding contact between certain elements and a tendency for them to alternately seize and separate with "stick-slip" or chattering action. Ordinary lubricants such as straight mineral oil and a number of products especially compounded for the purpose do not prevent this objectionable type of operation. For example, the lubricants specifically recommended by the manufacturer of this transmission, known as Automatic Transmission Fluids, Type A, are completely inadequate for preventing this chattering action. This is true despite the fact that these approved fluids vary widely in their compositions and contain a wide variety of detergent inhibitor additives, anti-friction additives, and other materials. However, when the fluids described in this invention are used, the objectionable chatter, particularly common when certain transmissions are operated in reverse, is almost completely eliminated.

As has been previously mentioned, lubricants for use in automatic hydraulic transmissions must, in addition to other important properties, possess a high degree of detergency, freedom from corrosion, and good odor. According to the present invention, it has been discovered that a particular combination of detergent inhibitors and acidic type materials, when combined in the correct proportions, give a fluid that has these desirable

properties in optimum combination. The specific acidic materials to be employed in a given fluid depend upon the exact detergent-inhibitor used and the detailed fluid properties desired. Oleic acid or similar unsaturated long chain fatty acids, or natural fats containing acids of this type (such as lard oil), may be used as anti-friction agents where detergent-inhibitors such as P_2S_5 treated barium salt of diisobutyl phenol sulfide are employed.

Even better anti-friction properties can be obtained by the inclusion of certain phosphoric acid esters, especially triphosphate esters such as tricresyl phosphate, along with the acid type anti-friction agent. Saturated long chain fatty acids such as stearic acid or alkyl mercapto acids such as lauryl mercaptoacetic acid cannot be employed with detergent-inhibitors of this type. By substituting an unsaturated acid such as oleic acid, or lard oil, H_2S evolution is reduced, probably by being taken up at the unsaturated bonds. When saturated acids are employed, H_2S evolution occurs, resulting in objectionable odor and corrosion properties despite the fact that good anti-friction action is obtained. Also, substitution of a non-P_2S_5 treated detergent-inhibitor such as the barium salt of diisobutyl phenol sulfide for the P_2S_5-treated detergent material would reduce H_2S evolution. However, such substitution cannot be made without destroying the effectiveness of the anti-friction agent. Neither can detergent-inhibitors containing petroleum sulfonates be employed for the same reason.

For improved anti-corrosion properties, combined with better detergency and better odor than is obtained with oleic acid-P_2S_5-treated detergent type blends, it is preferred to use non-P_2S_5-treated detergent inhibitors. However, neither the saturated or unsaturated fatty acids nor the mercapto acids are effective anti-friction agents in the presence of these non-P_2S_5-treated detergent-inhibitors. It has been discovered, and is another feature of this invention, that if certain concentrations of fatty acid and alkylmercapto acid are employed jointly, excellent anti-friction properties result even in the presence of the non-P_2S_5-treated detergent-inhibitors. Also, very good odor and corrosion properties are observed for blends of this type because of absence of free H_2S. Sulfonate-containing detergent-inhibitors cannot be used, however, without destroying the anti-friction properties.

The invention will be more fully understood by specific reference to a series of blends which have been made in the study of the anti-friction problem. In general, two types of detergents were employed. One of these was a highly successful commercial product obtained by treating the barium and/or calcium salt of diisobutyl phenol sulfide with a phosphorus sulfide such as P_2S_5. The other consists of the untreated barium or mixed barium-calcium salt of diisobutyl phenol sulfide. The former gives superior anti-friction properties in combination with fatty acids but has an objectionable tendency to evolve H_2S gas under certain conditions. The untreated salt, on the other hand, is free from the objectionable H_2S evolution but is somewhat deficient alone or in combination with fatty acids, as an anti-friction agent in mineral base lubricating oil.

By combining certain concentrations of fatty acid of the C_{12} to C_{22} range with a C_8 to C_{24} alkyl mercapto acid, specifically lauryl mercapto acetic acid, the combination is found to possess all the desired properties to an excellent degree. In the mercapto acids, instead of lauryl the alkyl group obviously may be octyl, 2-ethyl hexyl, decyl, tetradecyl, etc. Among the C_{12} to C_{22} fatty acids that may be used are myristic, palmitic, stearic, erucic, brassidic, etc. In either case the addition of a small amount of tricresyl phosphate serves to improve anti-friction properties slightly further.

The preferred embodiments of this invention may be

summarized as follows where the detergent-inhibitor A represents the type which is free from H_2S evolution, such as non-P_2S_5-treated barium or calcium salt of alkyl phenol sulfides, and type B represents the type which is subject to H_2S evolution because of prior treatment with a phosphorus sulfide.

Anti-Friction Agents	Concentration, Weight Percent	Detergent-Inhibitor	Other Additive
1. Stearic Acid	0.3–0.4	A	Pour depressant, V. I. Improver, Anti-foam Agent.
Lauryl Mercapto Acetic Acid	0.2–0.3		
(Tricresyl Phosphate) [1]	0.5–1.0		
2. Oleic Acid (or No. 1 Lard Oil)	0.7–1.0 (2.0)	B	Pour depressant, V. I. Improver, Anti-foam Agent.

[1] May be omitted at the expense of a slight impairment of anti-friction properties.

A series of tests was made of various compositions in an actual hydraulic transmission of the torque converter type where a strong tendency to chatter was found in reverse gear operation. In the particular transmission used, there is a large steel bearing surface in the reverse planetary gear set which rotates against a bronze bushing when the unit is put into reverse. This bearing is lubricated by the transmission fluid. As will be seen by reference to the data in Table I, when either straight mineral oil or the fluids presently approved by the manufacturer of this transmission are used, "stick-slip" occurs in this bearing, and undesirable chatter is obtained. When the fluids described in this invention are used, the chatter is almost entirely eliminated.

Table I

Fluid		Torque Converter Reverse Chatter
Anti-Friction Agent	Deter.-Inhibitor	
1. Approved Type A fluids [1]		Medium to Heavy.
2. Straight mineral oil		Heavy.
3. 0.3% Stearic acid	None	Very Light to Light.
4. 0.3% Oleic acid	do	Medium to Heavy.
5. 0.8% Oleic acid	do	Very Light.
6. 0.8% Oleic acid	2.0% Detergent B	Light.
7. 0.3% Stearic acid	do	Light (Objectionable Odor).
8. 0.3% Stearic acid	2.0% Detergent A	Medium to Heavy.
9. 0.2% Lauryl mercapto acetic acid.	do	Do.
10. 0.3% Stearic acid, 0.2% Lauryl mercapto acetic acid.	do	Very Lt. to Light.
11. No. 10+0.5% Tricresyl phosphate		Very Light.
12. 0.4% Stearic acid, 0.5% Tricresyl phosphate	2.0% Detergent A	Medium to Heavy.
13. 0.3% Lauryl mercapto acetic acid, 0.5% Tricresyl, phosphate	do	Do.
14. 0.2% Lauryl mercapto acetic acid, 0.3% Stearic acid	(2.0% Detergent A, 1.2% Calcium sulfonate concentrate.	Light to Medium.
15. 2.0% No. 1 Lard Oil	2.0% Detergent B	Light.

[1] Recommended by manufacturer for use in this transmission.

The concentration of the fatty acid and mercapto acid to be employed will depend upon the nature of the other ingredients present and the required anti-friction properties. In general, the best concentration range for the fatty acids is from about 0.2 to 1.0% by weight, and for the mercapto acetic acid about 0.2 to 0.4%. Lower concentrations result in decreased effectiveness while higher concentrations are objectionable from the standpoint of oxidation stability and corrosion. If tricresyl phosphate is also employed, a concentration of about 0.5% by weight has been found to be effective. Of those listed above in Table I, compositions Nos. 6, 10, 11 and 15 are most satisfactory over-all.

In general, the invention contemplates the use of a lubricating oil as a major compenent. This is preferably a mineral base lubricating oil, although synthetic oils such as dibasic acid esters, complex esters, polyglycols, and the like may be used so long as they are compatible with the additives. The preferred viscosity range is between 35 and 65 S. S. U. at 210° F., particularly between 45 and 55 for the average transmission unit.

This lubricating oil base should contain about 1 to 6% by weight, based on the total composition, of an alkaline earth metal salt of alkyl phenol sulfide as a detergent, which is free from H_2S evolution together with 0.2 to 1% by weight of fatty acid of the C_{12} to C_{22} range, 0.2 to 0.5% by weight of C_8 to C_{18} alkyl mercapto acid, preferably an alkyl mercapto acetic acid, and 0 to 1% by weight, preferably at least 0.2%, of a tri-ester of phosphoric acid, e. g. tricresyl phosphate, as an oiliness agent. When mineral oil is used as the fluid base it preferably has a viscosity between 35 and 65 S. S. U. at 210° F. and is of reasonably high viscosity index. A preferred composition comprises 93.7 to 97.4% of such a mineral base oil with 2 to 6% of the alkaline earth salt of non-P_2S_5-treated alkyl phenol sulfide as detergent, 0.3 to 1% of a fatty acid, preferably a C_{18} acid, stearic acid being first choice, 0.1 to 0.3% of lauryl mercapto acetic acid although other alkyl derivatives may be used, and 0.2 to 1% of tri-cresyl phosphate.

It is to be noted that the invention as described contemplates the use of alkaline earth metal salts derived from the alkyl phenol sulfides as the preferred detergents, and that the exact detergent-inhibitor to be employed will depend upon the nature of the acidic type anti-friction additive to be used. It is also to be noted, however, that other detergent-inhibitors may also be used provided they do not interfere with the activity of the anti-friction agents employed or do not result in objectionable corrosion or odor properties. Various other additives may also be included as required to impart specific properties to the blend such as conventional antioxidants, pour depressants, viscosity index improvers, anti-foam agents, and the like.

What is claimed is:

1. A lubricant composition of high detergency and superior anti-friction properties, comprising a major proportion of a liquid lubricating oil base, 1 to 6% by weight, based on the total composition of an H_2S free alkaline earth metal salt of alkyl phenol sulfide as a detergent, 0.2 to 1% of fatty acid of the C_{12} to C_{22} range, and 0.2 to 0.5% of C_8 to C_{24} alkyl mercapto acetic acid.

2. Composition according to claim 1 to which is added 0.2 to 1% of a triester of phosphoric acid as oiliness agent.

3. A hydraulic transmission oil having approximately the following composition by weight:

92.5 to 98.6% lubricating oil base of 35 to 65 S. S. U. vis. at 210° F.
2 to 5% alkaline earth metal salt of diisobutyl phenol sulfide
0.3 to 1% C_{18} fatty acid
0.2 to 0.5% lauryl mercapto acetic acid
0.2 to 1.0% tricresyl phosphate.

References Cited in the file of this patent

UNITED STATES PATENTS

2,203,102	Powers	June 4, 1940
2,409,686	McNab	Oct. 22, 1946
2,451,345	McNab et al.	Oct. 12, 1948
2,474,604	Wasson et al.	June 28, 1949
2,516,119	Hersh	July 25, 1950
2,528,347	Denison	Oct. 31, 1950