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LUBRICATING OIL COMPOSITION

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This invention relates to the lubrication of internal combustion engines; and is particularly directed, although not restricted, to satisfactory and improved lubrication in the Diesel type of engine wherein extreme service conditions of temperature and pressure are encountered. To the attainment of these and other ends, the invention provides and encompasses compounded liquid petroleum compositions consisting essentially of motor lubricating oil with an aluminum soap of a saturated fatty acid and a glycol or diglycol mono-ether as compounding ingredients. The compounded products retain substantially the viscosity and flow characteristics of an oil, and thereby distinguish from other compounded lubricants of the plastic flow type such as greases and so-called liquid greases.

Modern engine design has made lubrication of internal combustion engines an increasingly difficult and specific problem. In high speed units and especially in Diesel engine, lubrication is required under service conditions of such severity as to approach the limit of safe and efficient operation with straight mineral oils. High temperatures and pressures, the catalytic effect of hot metallic surfaces continuously contacted under these conditions, accumulating concentration of oxidation products, and autocatalytic effect developing as deterioration progresses all contribute to lubricant degradation. The lubricating capacity of the oil is rapidly diminished by chemical and thermal deterioration, and the products of deterioration create serious operating problems. Gummy or lacquer-like products, sludges, asphaltenes and coke are formed and the accumulation of such material has a naturally harmful effect upon engine parts and operation. Ring sticking, ineffective cylinder lubrication, increased wear, scoring of cylinder walls and like trouble results, and frequent shutdown for cleaning, overhauling and often replacing of engine parts may be necessary.

According to the present invention, the foregoing difficulties are obviated by lubricating internal combustion engines with a compounded lubricant comprising hydrocarbon lubricating oil, an aluminum salt of a saturated fatty acid and a mono-ether of a glycol or a diglycol.

There is evidence that the mono-ethers of glycols and mono-ethers of diglycols react with or modify aluminum soaps of saturated fatty acids; and I believe that my compounded lubricating composition contains a modified aluminum soap of a saturated fatty acid or an aluminum soap-glycol or diglycol mono-ether complex along with which may be some proportion of the respective compounding ingredients as added. It is to be understood, therefore, that such expressions as "lubricating composition comprising hydrocarbon lubricating oil, an aluminum soap of a saturated fatty acid and a glycol or diglycol mono-ether," "hydrocarbon lubricating oil compounded with an aluminum soap of a saturated fatty acid and a mono-ether of a glycol or a mono-ether of a diglycol," or the like, are intended to designate and embrace any liquid hydrocarbon lubricating oil composition in which an aluminum soap of a saturated fatty acid and a mono-ether of a glycol or a diglycol have been incorporated regardless of what complex compound or mixture may actually exist in the compounded product.

The exact chemical mechanism of mineral oil deterioration in internal combustion engine service is not clear although authorities have reasonably concluded that such phenomena as polymerization, oxidation and thermal decomposition are predominant factors. It is not intended, however, to limit or attempt an explanation of results attending lubrication of internal combustion engines with the compounded oil of the invention on the basis of these or other theories. Results marking a distinction between success and failure in engine performance and lubrication are sufficient evidence that the compounding of an aluminum soap of a saturated fatty acid and a glycol or diglycol mono-ether with hydrocarbon lubricating oil performs a novel and highly useful function.

Engine tests are to be preferred for the comparative evaluation of motor oils, especially when intended for service in the lubrication of Diesel engines, although the well known Indiana oxidation test or a modification thereof in which the test is carried out in the presence of a weighed quantity of steel wool may serve to provide an index. Sludge values do not seem to have particular significance but the character of the oxidation products at the end of a 70 hour run at 341° F. is an indication of conditions that may be expected in engine service. Good Diesel engine lubricants generally give a clean tube without resinous or gummy products adhering to the walls. If the sludge is sticky, gummy and unfilterable, the probability is that the oil will cause ring sticking in engine service. In the modified Indiana test there is usually a slight decrease in weight of the steel wool with promising oils and the steel wool when washed clean with hot kerosene followed by naphtha has a bright appear-

ance. In the case of unsuitable oils the steel wool shows a definite increase in weight after the 70 hour test run.

For demonstrating the operative significance of compounded lubricants according to the present invention, actual lubrication of engines both of the spark ignition and of the compression ignition type was relied upon as the significant criterion. Collateral indications were obtained with the Indiana oxidation test and with the modified form of this in which the test is carried out in the presence of a weighed quantity of steel wool. In all test operations, comparison was with blank runs in which straight mineral oil as used in the compounding of a given lubricant according to the invention supplied the lubrication.

The compounding of an aluminum soap of a saturated fatty acid and a glycol mono-ether with a hydrocarbon oil intended for service in the lubrication of internal combustion engines gave consistently improved results in all tests. In both automotive and Diesel engine service ring sticking and related difficulties were substantially to entirely eliminated, with the lubricant continuing to perform its lubricating function satisfactorily over extended test periods under rigorous operating conditions. Good general engine condition was observed upon inspection at the termination of the tests. In comparative test runs, straight mineral oils were markedly inferior, especially in Diesel engine service where relatively short runs resulted in badly stuck rings, inadequate lubrication and poor general engine condition at shutdown.

The invention has general utility in the art of motor oil preparation and use. The base stock which is compounded as disclosed herein may comprise any hydrocarbon lubricating oil and is not restricted to particular crude petroleum sources or to particular degrees of refining. For example, aluminum stearate and butyl carbitol have been compounded with motor oil from Pennsylvania crude and with motor oil from an asphaltic-naphthenic California crude. In each case like benefit in the way of improved lubrication and elimination of ring sticking or like engine trouble ensued. This is a particularly advantageous feature of the invention. Many compounds proposed for addition to petroleum oils are, as is well known, effective or compatible only with certain specific oils of prescribed crude origin.

In general it is preferred that the base stock used in preparing lubricating compositions as herein be a motor oil which has had a good or superior degree of refining in the course of production. In the case of naphthenic or asphaltic base stocks a refining treatment with sulfuric acid or a combination of solvent extraction and acid treatment is recommended. With Pennsylvania and like paraffinic base stocks less rigorous refining treatment is necessary. One reason for the stated preference is the conventional desirability of good or quality lubricating oil simply from the viewpoint of superior capacity as a lubricant. In a more pertinent aspect, however, I believe that my compounded lubricating composition has greater general utility in internal combustion engine service and gives better overall performance when well refined base stock is used.

In one embodiment, the lubricating compositions of the invention may be prepared by introducing suitable proportions of an aluminum soap (for example, 1% by weight based on the oil) into a selected motor oil at ordinary temperature, agitating thoroughly for sufficient time to obtain a well disseminated mixture of soap in oil, adding suitable proportions of an appropriate ether (for example, 0.1% by weight based on the oil) to the still agitated mixture, applying heat sufficient to raise the temperature to about 300–340° F., and maintaining the mixture at such temperature for approximately two hours, agitation being continued throughout the treatment. Aluminum soaps utilized in the present invention are but sparingly soluble in mineral oil of lubricating oil viscosity, and when added at room temperatures tend to agglomerate—hence the desirability of thoroughly stirring the soap-oil mixture prior to the addition of a glycol or diglycol mono-ether. If the soap-oil mixture is heated prior to the ether addition, viscosity builds up and at about 190–220° F. there is a marked gelling effect which offers considerable resistance to agitation at this temperature stage. As heating is continued, the gel thins out somewhat and the mixture may be stirred without excessive power consumption. If desired, this procedure may of course be used and the appropriate mono-ether added after the mixture has been raised to elevated temperature.

It is far more desirable, however, to introduce the mono-ether into an agitated soap-oil mixture before applying heat to the latter since in this procedure no abnormal viscosity increase or gel formation occurs during the heat treatment and a fully fluid mixture is maintained throughout. Apparently some reaction between the compounding agents or ingredients is initiated immediately upon admixture, and this progresses as heat is applied.

As indicated above, the mixture of oil and both compounding ingredients is heated at elevated temperature preferably 300° F.–340° F. for about two hours which is usually sufficient. If the heat treatment has been insufficient for necessary completeness of reaction, the oil upon cooling to room temperature will be turbid and some further heating is required. Ordinarily, however, the indicated temperature and time of heating suffices to prepare a clear oil solution comprising the improved motor oil of the invention. Additional heating not unduly prolonged does no harm.

With most oils a temperature above about 340° F. might be used if care is exercised but this is not regarded are particularly desirable since the objectives of the invention are satisfactorily attained with greater certainty and economy when the temperature does not exceed 340° F. Temperatures somewhat below 300° F. may be used successfully but with lower temperatures a longer period of heat treatment naturally is required.

Aluminum soap of high purity is desired in the practice of the invention. Some such soaps, for example the commercial aluminum stearates, contain small amounts on the order of 0.5% to 3% of inorganic salts such as sodium sulfate. This is not especially objectionable, although with some oils the higher proportions of inorganic impurity may occasion a small degree of difficultly removable sedimentation upon storage of the compounded lubricating composition. This does not, however, seem to have any particularly deleterious effect in engine service although the oil naturally is inferior in appearance to compounded oils which are clear solutions as are usually ob-

tained in the preparation of lubricating compositions according to the invention.

As indicated hereinbefore, the acid radical of the soap herein is of the saturated type and the higher fatty acids are preferred. Commonly available or naturally occurring fatty acids have carbon atoms within the range of 12 to 22 in number, and aluminum soap for the purposes of the invention advantageously may be derived from saturated acids in this group. Aluminum stearate and aluminum palmitates may be mentioned by way of specific example. Mixtures of aluminum soaps of saturated fatty acids may be used.

The mono-, di-, and tri-soaps of aluminum are available or may be readily prepared by methods well known in the art. In each instance it is probable that the product contains some impurity percentage of one or both of the other forms with possibly some free acid as well. In most of my exploratory practice of the invention I have used the di-soap, for example aluminum di-stearate, and this is the present preferred embodiment, but the mono-soaps and tri-soaps likewise have utility in the preparation of compounded lubricating oils as herein. The ash content, of course, differs with the three forms and when motor oil specifications include a maximum allowable ash, this must be given consideration in selecting the proportion of a particular aluminum soap to be used in the preparation of the compounded oil. For example, the mono-stearate and the mono-palmitate give higher percentages of ash than the di-stearates and the di-palmitates, and therefore a larger weight proportion (based on the oil) of the latter can be used while still meeting a prescribed ash in the compounded oil.

The ethers used as compounding or modifying agents according to the invention comprise the mono-ethers of glycols or of diglycols. These may be in general designation described as the mono-alkyl, mono-aryl, mono-aryl-alkyl and mono-alkyl-aryl ethers of glycols or of diglycols. The mono-butyl ether of di-ethylene glycol is known commercially as butyl carbitol, and this compound is quite suitable for and has been used with benefit in the practice of the invention. Other illustrative compounds falling within the general class to which the concept of the invention is applied are mono-methyl ether of di-ethylene glycol, mono-butyl ether of di-ethylene glycol, mono-methyl of tri-ethylene glycol, mono-phenyl ether of di-ethylene glycol, and mono-ethyl ether of propylene glycol. Certain of these and other members of the general class are available through regular commercial channels in the chemical market. Others not commonly available on the open market may be readily synthesized by methods well familiar to those skilled in the art and available in the existing literature. Mixtures of various glycol or diglycol mono-ethers also may be used to modify aluminum soaps in the compounding of lubricating oil compositions according to the present invention.

Lubricants within the contemplation of the invention all are substantially liquid and non-stringy oils in distinct contrast from compositions of the prior art generally designated as mineral castor oils. The lubricating compositions of the invention generally have a higher viscosity and viscosity index than the motor oil used as a base stock. If the increase in viscosity is reasonably limited within the conventional requirements for particular services, this is a distinct advantage, but the necessity of avoiding too great a deviation from given specifications for different grades of motor oil makes it undesirable to have excessive viscosity increase in the compounded product. I have found that advantages in the way of improved lubrication and engine operation are readily and consistently obtained with lubricating compositions of the invention when the viscosity of the compounded product is increased only to a reasonable and desirable degree.

Proportions of aluminum soap and of glycol ether to be used as compounding ingredients for the purposes of the present invention will vary with oils from different crude sources and with differently refined oils from the same or different crude sources. In any given instance a degree of latitude is available in respect of desired proportions, and the amounts of each ingredient are selected with regard both to relative and conjoint effect. Where a percentage of ash is a fixed specification for an oil to be used in particular service (as is sometimes specified for Diesel engine lubricants) this will determine the upper limit of aluminum soap that can be used. More generally, the viscosity of the compounded product may be regarded as a limiting factor. Beyond about 2% or 3% of aluminum soap, the viscosity is increased by the soap to some degree independently of the compounding ether.

Relative to each other, the proportion of selected ether must be sufficient to avoid more than moderate increase in viscosity due to the addition of aluminum soap. In other words, the lubricating compositions are formed by compounding with a hydrocarbon lubricating oil of suitable nominal viscosity for an intended service small amounts of an aluminum soap of a saturated fatty acid and a glycol mono-ether or a diglycol mono-ether in proportions such that the normal viscosity of the oil is not increased beyond a reasonable degree for its intended service. More useful members of the class of mono-ethers of glycols and diglycols are soluble per se in hydrocarbon lubricating oil to a degree exceeding the requirements of the present invention and may, therefore, be used in compounding proportion greater than that necessary for conjoint action with aluminum stearate as herein. Some degree of benefit results from the presence of these mono-ethers in mineral oils, and an economical excess of this constituent consequently may be desirable.

By way of specific illustration, I have found that with good quality commercial aluminum di-stearate, effective and suitable proportions of the mono-butyl ether of di-ethylene glycol (i. e., butyl carbitol) fall in the range of about 5% to about 20%, and preferably about 8% to about 15%, of the soap. In many experiments using a well refined Pennsylvania base motor oil of S. A. E. 20 grade as a base stock I have found that butyl carbitol as 10% of the soap (e. g. aluminum stearate 1% and butyl carbitol 0.1%, both by weight based on the weight of motor oil used in the compounding) gives very satisfactory results in every regard. Optimum proportions of butyl carbitol relative to aluminum stearate will vary when different motor oils comprise the base stock; and likewise will vary to some extent depending upon the amount of soap. With larger proportions of soap the butyl carbitol proportion generally should be larger. I believe that motor oils compounded with about 1.0%–1.5% by weight of aluminum stearate and proportions by weight

of butyl carbitol equal to about 8–10% of the soap will provide lubricating compositions according to the invention which are entirely satisfactory for the majority of contemplated services.

With soaps other than aluminum di-stearate and with glycol mono-ethers or diglycol mono-ethers other than the mono-butyl mono-ether of di-ethylene glycol, optimum relative proportions of compounding ingredients will vary somewhat but the general relation of the two components will be substantially in line with the data of the foregoing example. In any given instance, however, the desired proportions of materials may be readily determined by simple experiment, and the specific illustrative disclosures herein are not intended in a limitative sense.

This application is a continuation-in-part of my co-pending application Serial No. 200,073, filed April 5, 1938, now Patent No. 2,260,341, issued October 28, 1941.

I claim:

1. Substantially liquid and non-stringy lubricating oil for internal combustion engines operating at high sustained speeds and under extreme service conditions of temperature and pressure such as may be encountered in Diesel engine lubrication, which comprises a hydrocarbon lubricating oil of suitable nominal viscosity for an intended service compounded and heated with small amounts of an aluminum soap of a saturated fatty acid and a compound selected from the class consisting of glycol mono-ethers and diglycol mono-ethers in proportions such that the normal viscosity of the oil is not increased beyond a reasonable and desirable degree for its intended service, the aluminum soap being introduced in an amount not less than one per cent.

2. Substantially liquid and non-stringy lubricating oil for internal combustion engines operating at high sustained speeds and under extreme service conditions of temperature and pressure such as may be encountered in Diesel engine lubrication, which comprises a hydrocarbon lubricating oil of suitable nominal viscosity for an intended service compounded and heated with small amounts of an aluminum soap of a saturated fatty acid and a glycol mono-ether in proportions such that the normal viscosity of the oil is not increased beyond a reasonable and desirable degree for its intended service, the aluminum soap being introduced in an amount not less than one per cent.

3. Substantially liquid and non-stringy lubricating oil for internal combustion engines operating at high sustained speeds and under extreme service conditions of temperature and pressure such as may be encountered in Diesel engine lubrication, which comprises a hydrocarbon lubricating oil of suitable nominal viscosity for an intended service compounded and heated with small amounts of an aluminum soap of a saturated fatty acid and a diglycol mono-ether in proportions such that the normal viscosity of the oil is not increased beyond a reasonable and desirable degree for its intended service, the aluminum soap being introduced in an amount not less than one per cent.

4. Substantially liquid and non-stringy lubricating oil for internal combustion engines operating at high sustained speeds and under extreme service conditions of temperature and pressure such as may be encountered in Diesel engine lubrication, which comprises a hydrocarbon motor oil of suitable viscosity for the intended service compounded with approximately 1% by weight of an aluminum soap of a saturated fatty acid and a quantity of a compound selected from the class consisting of glycol mono-ethers and diglycol mono-ethers, in the range of about 5% to 20% by weight of said aluminum soap, sufficient to improve the lubricating efficiency of the oil, the ingredients of said compounded oil being subjected to a heat treatment at an elevated temperature and for a period of time sufficient to produce a resulting product which has substantially the viscosity and fluidity characteristics of the uncompounded oil.

5. Substantially liquid and non-stringy lubricating oil for internal combustion engines operating at high sustained speeds and under extreme service conditions of temperature and pressure such as may be encountered in Diesel engine lubrication, which comprises a hydrocarbon motor oil of suitable viscosity for the intended service compounded with approximately 1% by weight of an aluminum soap of a saturated fatty acid and a quantity of a glycol mono-ether, in the range of about 5% to 20% by weight of said aluminum soap, sufficient to improve the lubricating efficiency of the oil, the ingredients of said compounded oil being subjected to a heat treatment at an elevated temperature and for a period of time sufficient to produce a resulting product which has substantially the viscosity and fluidity characteristics of the uncompounded oil.

6. Substantially liquid and non-stringy lubricating oil for internal combustion engines operating at high sustained speeds and under extreme service conditions of temperature and pressure such as may be encountered in Diesel engine lubrication, which comprises a hydrocarbon motor oil of suitable viscosity for the intended service compounded with approximately 1% by weight of an aluminum soap of a saturated fatty acid and a quantity of a diglycol mono-ether, in the range of about 5% to 20% by weight of said aluminum soap, sufficient to improve the lubricating efficiency of the oil, the ingredients of said compounded oil being subjected to a heat treatment at an elevated temperature and for a period of time sufficient to produce a resulting product which has substantially the viscosity and fluidity characteristics of the uncompounded oil.

7. Method of preparing motor oil composition suitable for the lubricating of internal combustion engines, which comprises compounding hydrocarbon lubricating oil of suitable viscosity for the intended service with approximately 1% by weight of an aluminum soap of a saturated fatty acid and a quantity of a compound selected from the class consisting of glycol mono-ethers and diglycol mono-ethers, in the range of about 5% to about 20% by weight of said aluminum soap, sufficient to improve the lubricating efficiency of the oil, and then subjecting the resulting mixture to a heat treatment at a temperature not substantially lower than 300° F. for a period of time sufficient to produce a resulting product which has substantially the viscosity and fluidity characteristics of the uncompounded oil.

8. Method of preparing motor oil composition suitable for the lubricating of internal combustion engines, which comprises compounding hydrocarbon lubricating oil of suitable viscosity for the intended service with approximately 1% by weight of an aluminum soap of a saturated fatty acid and a quantity of a glycol mono-ether, in the range of about 5% to about 20% by weight of said aluminum soap, sufficient to improve the lubricating efficiency of the oil, and then sub-

jecting the resulting mixture to a heat treatment at a temperature not substantially lower than 300° F. for a period of time sufficient to produce a resulting product which has substantially the viscosity and fluidity characteristics of the uncompounded oil.

9. Method of preparing motor oil composition suitable for the lubricating of internal combustion engines, which comprises compounding hydrocarbon lubricating oil of suitable viscosity for the intended service with approximately 1% by weight of an aluminum soap of a saturated fatty acid and a quantity of a diglycol mono-ether, in the range of about 5% to about 20% by weight of said aluminum soap, sufficient to improve the lubricating efficiency of the oil, and then subjecting the resulting mixture to a heat treatment at a temperature not substantially lower than 300° F. for a period of time sufficient to produce a resulting product which has substantially the viscosity and fluidity characteristics of the uncompounded oil.

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