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LUBRICATING OIL COMPOSITION

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This invention relates to mineral lubricating oil compositions of good viscosity characteristics. It relates particularly to the blending of new type synthetic compounds in mineral lubricating oils, thereby establishing a lower rate of change of viscosity with temperature upon the blended oil than upon the unblended oil.

Viscosity, as one of the more important physical properties of a lubricating composition, is significant as to its actual value at a particular temperature and as to its rate of change with temperature. In the petroleum industry, the significance of the first aspect is indicated by the S. A. E. number and the second by certain established scales, such as viscosity index, viscosity gravity constant and viscosity pole height.

One of the outstanding scales for evaluating lubricating oils upon the basis of their viscosity temperature variation is that advanced by Dean and Davis in Chemical and Metallurgical Engineering, volume 36, page 618 (1929). This method is commonly known as the viscosity index scale. According to this system of classification, the viscosity of an oil is determined accurately at the two temperatures of 100° F. and 210° F. in Saybolt Universal seconds and compared at these temperatures with the viscosities of certain standard oils. At the time the scale was advanced, a standard oil of exceptionally low rate of viscosity change was rated as 100, while a second oil of exceptionally high rate of viscosity change was rated as zero.

If an oil has a low viscosity index, that is, the viscosity changes rapidly with changes in temperature, it may be viscous enough to function satisfactorily at one temperature from the point of view of viscosity, but wholly unsatisfactory at another temperature because of the low viscosity or "body" of the oil. Another oil of low V. I. characteristics may be satisfactory at engine operating temperatures for automobile performance, but wholly unsatisfactory at low temperatures in presenting difficulty of starting the engine due to its extremely high viscosity, rendering it difficult to move the engine parts with the power available.

Of the various types of lubricating oil distillates derived from crudes, the paraffinic base oils have the best general viscosity characteristics, while those of naphthenic base have the poorest viscosity characteristics. By refining, however, an improvement in general viscosity characteristics can be attained upon both types of crudes as well as the distillates from the mixed base crudes. Refining to improve viscosity index to any great ex-

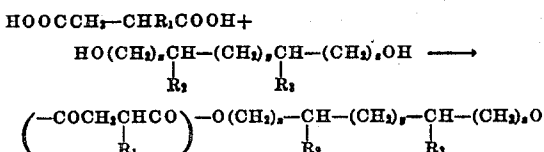
5 tent, however, such as by solvent extraction or heavy acid treatment, is usually costly. Also, when oils are extensively treated, the thus treated oils are less chemically stable. Such chemical instability is shown in service and in laboratory testing for resistance to oxidation and corrosion towards alloy bearings. Usually, therefore, it is considered more commercially advantageous to refine oils according to general standard and to effect further improvements as considered advisable by the addition of particularly effective compounds such as, in this case, the addition of compounds particularly effective to improve viscosity index.

10 A number of lubricating oil addition agents which reduce the viscosity temperature variation of oils are already well-known in the art. A compound to be advantageous as a viscosity index improver has to be satisfactorily soluble in mineral lubricating oils, effective in low concentrations and substantially stable under conditions of usage to which a blended composition is subjected in service.

15 A class of compounds which have been extensively investigated is the linear chain, two-dimensional, polymeric compounds having molecular weights above 800. By the term "linear chain, two-dimensional, polymeric compound" is designated that class of polymeric compounds which are theoretically visualized as consisting of long chains or threads in contrast to the so-called three-dimensional polymers, in which molecular growth is visualized as having been effected by reactions in three dimensions. The physical difference between the two types of polymers is that with the linear polymers, the physical characteristics are more of the nature of viscous liquids, while those of the three-dimensional polymers are more or less resinous compounds insoluble in mineral lubricating oils. In "High Polymers" collected papers of W. H. Caruthers (Mark & Whitby), vol. I, page 15, linear polymers are considered characterized by a recurring structural unit, usually a bivalent radical. The polymeric compound of this invention is considered to be a condensation or C polymer, that is, a polymeric molecule formed from monomeric compounds by a process of polyintermolecular condensations.

20 In accordance with the present invention, high molecular weight polyesters derived by the condensation of certain dibasic acids and glycols have been found to be advantageous as viscosity index improvers for lubricating oils in concentrations between 0.5% and 5.0% by weight and as a preferred range from 0.75% to 3.0%. The polyesters of this invention are formed by the con-

densation of succinic acids which are preferably alkylated, with a glycol which may or may not be alkylated. The condensation products are predominantly linear in structure and are completely soluble in lubricating oils. The reaction may be formulated as follows:



where R₁ is an alkyl or alkene group having at least six carbon atoms and preferably between eight and eighteen. R₂ and R₃ may be hydrogen atoms or alkyl groups and y must be greater than one, and x and z may be 0 or an integer. If R₂ and R₃ represent alkyl groups containing up to about 10 carbons, the solubility of the resultant polyester in lubricating oils is increased, especially if R₁ is small. On the other hand, R₂ and R₃ may both be hydrogen atoms without adversely affecting the solubility of the polyester in mineral oils, provided R₁ is sufficiently large, that is, at least about 10 carbon atoms.

In practice it is preferable to use a glycol of the α, ω type. When such glycols are employed, the condensation proceeds smoothly and without the undesirable elimination of water and the formation thereby of an alkenol. The particular disadvantage of the formation of alkenols is that the linear chain formation is interrupted. However, by maintaining a reaction temperature of less than about 200° C., it is frequently possible to use a secondary or di-secondary glycol. Glycols with the OH groups on adjacent carbon atoms, such as are obtained by the hydration of alkene oxides or hydrolysis of alkene halohydrins, are not generally applicable because of the greatly increased tendency to form dimeric ring esters of the lactide type. Such esters are unreactive and the polyester compounds of little or no value as V. I. improvers.

In the general formula, the tendency of compounds to form rings decreases as x increases. It is preferred that x has a value between 4 and 10. When the values of R₁, R₂ and R₃ are within the preferred ranges, the percentage of oxygen in the polyesters is limited to between about 10% to 20%, and in this range they are satisfactorily soluble in mineral lubricating oils, and are very effective V. I. improvers in low concentrations, that is, between 0.5% and 5% by weight. Especially advantageous compounds are the linear polyesters formed from the reaction between alkylated succinic acid, in particular tri-isobutylene succinic acid and β-dodecyl tetramethylene glycol, hexamethylene glycol and decamethylene glycol.

To insure good mechanical stability of the polyesters, their average molecular weights are restricted to the range of 5,000 to 25,000. Their potency increases with molecular weight, but a point is always reached where the thermal and mechanical instability of the polyesters is sufficiently great to cause an appreciable drop in viscosity and V. I. of the blend with usage.

Alkylated succinic acids of the general formula



may be prepared from the dibromide of an α-olefin through the dinitrile or by condensing malonic ester successively with an alkyl halide and chloroacetic ester followed by decarboxylation. It is much simpler, however, to prepare these acids by

reacting an unsaturated hydrocarbon with maleic anhydride at a temperature of about 180° C. Thus, tri-isobutylene succinic acid was prepared by the addition of tri-isobutylene and maleic anhydride at 170° C.

Any of the α, ω glycols may be conveniently used in the condensation with the exception of ethylene and trimethylene glycols which form mainly the ring diesters. The glycols are generally prepared by the reduction of the esters of corresponding α, ω dibasic acids. Useful glycols with a side chain can also be made by reduction of esters of the alkylated succinic acids described above. Thus, β-dodecyl tetramethylene glycol is made by the catalytic hydrogenation of the diethyl ester of tri-isobutylene succinic acid at 2,000 lbs. pressure. Glycols with one secondary hydroxyl group, which serves to increase the number of side chains in the resultant polyesters, are typified by octadecane-1, 12-diol which is obtained by the hydrogenation of castor oil.

The formation of the polyesters is usually effected by heating equimolecular quantities of the alkylated succinic acid and the glycol at temperatures between 180 and 230° C. together with vigorous agitation and simultaneous contact with a stream of dry, inert gas such as nitrogen or carbon dioxide.

Example

Pure decamethylene glycol and an equimolecular quantity of tri-isobutylene succinic acid having a neutralization value of 391 mg. KOH per gm. were mixed and heated at 210-220° C. for about 24 hours. Dry hydrogen was bubbled through the molten mixture which was stirred rapidly. After 24 hours the mixture became highly viscous, and on cooling the product was stringy and tough. The improvement in Viscosity Index obtained by dissolving 2% of this material in an SAE 20 oil is shown by the following comparative data:

	Saybolt vis. 100° F.	Saybolt vis. 210° F.	V. I.
Mineral oil S. A. E. 20W	275.8	45.9	13
Mineral oil S. A. E. 20W+2% polyester	378.0	54.6	82

The above description and illustrative examples of the preparation and application of the compositions of the invention are presented for purposes of explanation but not of limitation of the invention. Modifications and variations can be made therein without exceeding the scope of the invention. It is intended to claim broadly the invention and it is to be limited only by the following claims or their equivalents.

What is claimed is:

1. A lubricating composition comprising a mineral lubricating oil and a viscosity-index increasing amount of an oil-soluble linear polyester reaction product of equimolecular proportions of tri-isobutylene succinic acid and decamethylene glycol, said polyester having a molecular weight in the range of about 5,000 to 25,000.

2. A lubricating composition comprising a mineral lubricating oil and 0.5 to 5% of a linear oil-soluble polyester reaction product having a molecular weight from about 5,000 to 25,000 of a substituted succinic acid containing an alkyl group of 8 to 18 carbons atoms and a glycol.

3. Composition according to claim 2 in which the substituted succinic acid is tri-isobutylene

succinic acid and the glycol is decamethylene glycol.

4. Composition according to claim 2 in which the substituted succinic acid is triisobutylene and the glycol is hexamethylene glycol.

5. A lubricating composition comprising a mineral lubricating oil and a viscosity-index increasing amount of an oil-soluble linear polyester reaction product of approximately equimolecular proportions of a substituted succinic acid substituted with a group selected from the class of alkyl and alkene groups of at least 6 carbon

atoms, and a glycol having at least 4 carbon atoms between the hydroxyl groups, said polyester having a molecular weight in the range of about 5,000 to 25,000.

6. Composition according to claim 5 in which the substituted succinic acid is tri-isobutylene succinic acid.

7. Composition according to claim 5 in which the polyester is formed from an α - ω glycol.

8. Composition according to claim 5 in which the glycol is a polymethylene glycol.

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