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(71) Applicant: HENKEL CORPORATION [US/US]; Suite 150, 140 Germantown Pike, Plymouth Meeting, PA 19462 (US).

(72) Inventors: LAKES, Stephen, C.; 323 Grove Avenue, Cincinnati, OH 45215 (US). BEIMESCH, Bruce, J.; 2499 Woodhill Court #11, Crescent Springs, KY 41017 (US).

(74) Agent: DRACH, John, E.; Henkel Corporation, Suite 150, 140 Germantown Pike, Plymouth Meeting, PA 19462 (US).

(54) Title: BASE STOCKS FOR TRANSMISSION/GEAR LUBRICANTS

(57) Abstract

Base stocks for synthetic lubricating oils for use in gear lubricants, automotive heavy and medium duty axle gear lubricants and transmission fluid applications are comprised of: (a) from about 30 % to about 80 % by weight of a poly-α-olefin having a branch ratio of greater than 0.19 and having a viscosity of from about 4 to about 8 cSt at 100 °C; (b) from about 1 % to about 20 % by weight of an ester having a viscosity such that a lubricant containing said base stock has a high temperature viscosity of from about 4 to about 25 cSt at 100 °C and low temperature viscosity of less than about 150,000 cps at -40 °C; (c) from about 10 % to about 30 % by weight of a polyisobutylene oligomer having a weight average molecular weight of from 7,500 to about 20,000 Daltons wherein the weight ratio of the poly-α-olefin to the ester is from about 5/1 to about 9/1.

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BASE STOCKS FOR TRANSMISSION/GEAR LUBRICANTS

BACKGROUND OF THE INVENTION

BENEFIT OF EARLIER FILING DATE UNDER 37 CFR 1.78(A)(4)

This application claims the benefit of earlier filed and copending provisional application serial number 60/022,808 filed on July 25, 1996.

1. Field of the Invention

This invention relates to base stocks for synthetic lubricants, specifically for gear oils, automotive heavy and medium duty axle gear lubricants and transmission fluid applications.

2. Statement of the Related Art

Transmission and gear lubricants are specialized types of lubricating oils. In addition to protecting metal parts from corrosion due to thermal, chemical and oxidative deterioration, transmission and gear lubricants must also provide protection against scoring and other types of mechanical distress. The protection for the gear or shaft touching surfaces are met by the oils antiwear (AW) or extreme pressure (EP) capabilities. Transmission and gear lubricants can be based on petroleum-refined oils or synthetic basestock materials. The petroleum-based transmission and gear lubricants are usually comprised of a petroleum refined distillate cut (mineral oil, solvent refined oil), an antioxidant, an antifoam, a corrosion inhibitor, and one or more antiwear or EP additives. In synthetic based transmission and gear lubricants, the petroleum refined basestock portion is replaced with such synthetic substances as synthetic hydrocarbons, esters,

polyglycols, phosphate esters, silicones, silicate esters, polyphenyl ethers, and halogenated hydrocarbons depending upon the particular application. It is well known in the art that certain synthetic based gear lubricants tend to last longer, exhibit better high temperature stability, have improved viscosity properties including viscosity index, and usually have lower pour points than petroleum-based lubricants.

Synchronized heavy and medium duty transmissions require lubricants having specific frictional properties, low deposition formation on molybdenum coated or steel sintered synchronizer plates, sufficient antiwear capabilities, proper viscometric properties for shift feel, sufficient high temperature viscosity for film strength and low antagonism toward bronze and other yellow metals.

Modern heavy and medium duty drive axles require lubricants with robust extreme pressure (EP) capabilities, proper viscometric properties for low and high temperature lubricant film strength, sufficient cleanliness under thermal and oxidative stability and low antagonism toward bronze and other yellow metals.

Extended drain transmission and gear lubricants demonstrate and maintain these capabilities beyond standard drain recommendations, exhibit excellent thermal and oxidative stability, maintain excellent cleanliness, have improved low and high temperature viscometric properties, impart improved seal life performance without the use of a seal swell agent, have excellent low temperature flow properties without the use of pour point depressants and demonstrate fuel economy benefits.

Existing base stocks for use in transmission and gear lubricants have been found to be inadequate for extended drain service because the petroleum basestock in conjunction with the additive systems show reduced lubricant performance under thermal and oxidative degradation. This degradation may exhibit increased operating temperature viscosities, higher temperature pour points, increased total acid number (TAN), insolubility of additive systems, attack on seal elastomers and sludging and carbon/varnish formation due to insolubility of the thermal/oxidative degradation by-products.

SUMMARY OF THE INVENTION

Base stocks for synthetic gear oils for use in gear oils, automotive heavy

and medium duty axle gear lubricants and transmission fluid applications are comprised of: (a) from about 30% to about 80% by weight of a poly-α-olefin having a branch ratio of greater than 0.19 and having a viscosity of from about 4 to about 8 cSt at 100°C; (b) from about 1% to about 20% by weight of an ester having a viscosity such that a lubricant containing said base stock has a high temperature viscosity of from about 4 to about 25 cSt at 100°C and low temperature viscosity of less than about 150,000 cps at -40°C; (c) from about 10% to about 30% by weight of a polyisobutylene oligomer having a weight average molecular weight of from 7,500 to about 20,000 Daltons wherein the weight ratio of said poly-α-olefin to said ester is from about 5/1 to about 9/1. Lubricant compositions containing the base stocks according to the invention have extended drain capabilities, exhibit enhanced oxidative and thermal stability, better viscosity properties at both low and high temperatures, improved shift feel, increased fuel economy benefits, improved seal life, decreased antagonism toward bronze and other yellow metals, and improved low temperature lubricant flow characteristics without pour point depressants.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Other than in the operating examples, or where otherwise indicated, all numbers expressing quantities of ingredients or reaction conditions used herein are to be understood as modified in all instances by the term "about".

The first component of a lubricant base stock according to the invention is a poly-α-olefin having a branch ratio of greater than 0.19 and a viscosity in the range of from about 4 centistokes to about 8 centistokes @ 100°C. Such a poly-α-olefin is typically prepared by the oligomerization of a 1-alkene in the presence of boron trifluoride, aluminum trichloride or a Ziegler catalyst and is characterized by having a branch ratio greater than 0.19. This type of poly-α-olefin is described in U.S. patent 4,827,064, the entire contents of which are incorporated herein by reference. Preferred poly-α-olefins are those which have a viscosity in the range of from about 4 centistokes to about 8 cSt @ 100°C and most preferably from about 4 to about 6 cst @ 100°C. The poly-α-olefin may be hydrogenated or non-hydrogenated. A combination of hydrogenated and non-hydrogenated poly-α-olefins can also be used. The amount of poly-α-olefin which can be used in the

compositions according to the invention can range from 30% by weight to 80% by weight, preferably from 50% by weight to 75% by weight. Preferred poly-α-olefins which can be used in the compositions according to the invention include poly-1-octene, poly-1-nonene, poly-1-decene, poly-1-undecene, poly-1-dodecene and combinations thereof. The combination of poly-α-olefins may be in the form of a mixture of individual poly-α-olefin homopolymers or one or more copolymers resulting from the copolymerization of a mixture of monomeric α-olefins. Most preferred poly-α-olefins are poly-1-octene, poly-1-decene, poly-1-dodecene. Examples of commercially available poly-α-olefins which can be used in the compositions according to the invention include Oronite Synfluid PAO's from Chevron Chemical Co., San Ramon, California, USA and Durasyn PAO's from Amoco Chemicals Corporation, Naperville, Illinois, USA.

The ester component of the lubricant base stocks according to the invention is any ester which has such a viscosity such that the final compounded lubricant utilizing this basestock and containing one or more additives as set forth below including a thickener will have a high temperature viscosity of from about 4 to about 25 cSt at 100°C and low temperature viscosity of less than about 150,000 cps at -40°C. One preferred type of such an ester is an aliphatic dicarboxylic acid ester wherein the alkyl group of the ester is a branched carbon chain having from about 8 to about 13 carbon atoms such as di-isodecyl adipate and di-isodecyl azelate. Another preferred type of ester according to the invention include C_{8-13} branched alkyl diesters of C_{4-12} aliphatic dicarboxylic acids. Preferred dicarboxylic acids are adipic and azelaic acids. Another type of such ester is a polyol ester wherein the polyol component of the ester is an aliphatic polyol having no beta hydrogen atoms and the acid component of the ester is an aliphatic branched or non-branched monocarboxylic acid having from 5 to 14 carbon atoms. Preferred polyols include trimethylolpropane, di-trimethylolpropane, triethylolpropane, neopentyl glycol, pentaerythritol or di-pentaerythritol and combinations thereof. The amount of the ester in the lubricant base stocks according to the invention can range from about 1% to about 20% by weight, and is preferably from about 5% to about 15% by weight. The esters according to the invention can be made by standard methods known to those

skilled in the art. An example of the preparation of an adipate ester is given in Example 1.

The polyisobutylene component of the lubricant base stock according to the invention can be any polyisobutylene having a weight average molecular weight of from about 7,500 to about 20,000 Daltons.

It has been observed that the swelling characteristics of automobile transmission seals is a function of the relative amounts of poly-α-olefin and ester. It has been determined that poly-α-olefin/ester weight ratio must lie in the range of from 5/1 to 9/1 preferably from 5/1 to 7/1 in order that lubricants containing the base stocks according to the invention provide acceptable swelling of automobile transmission and axle seals in the automotive transmissions and axles in which the lubricants are used.

It is also within the scope of the present invention to employ more than one type of each of the components of the lubricant base stocks according to the invention. Thus, more than one poly-α-olefin, more than one ester, and more than one type of polyisobutylene having a weight average molecular weight of from about 7,500 to about 20,000 Daltons can be combined as long as the resulting combination of the several components will yield a compounded lubricant having a high temperature viscosity of from about 4 to about 25 cSt at 100°C and low temperature viscosity of less than about 150,000 cps at -40°C.

The base stock according to the invention can also contain another polymer which can function as a thickener and/or a viscosity index improver. Such a polymer is selected from the group consisting of an ethylene-propylene copolymer; a polymethacrylate; a polystyrene; or a second poly-α-olefin having a viscosity of from about 40 to about 1,000 cSt at 100°C. The amount of a thickener and/or a viscosity index improver which can be used with the base stocks according to the invention is any amount that is required to achieve a desired viscosity and/or viscosity index. This amount will typically range from about 1% to about 40%by weight and is preferably from 7% to about 25% by weight. Suitable, commercially available thickeners include a 7500 molecular weight polyisobutylene commercially available as LUBRIZOL® L-3174 and L-3179, a polymethacrylate commercially available as Rohm and Haas Acryloid

956, 40 and 100 cSt polyalphaolefin commercially available as Mobil SHF 401 and 1001.

The base stocks according to the invention can also contain one or more additives typically employed in an AW or EP lubricant. Such additives include but are not limited to antirust additives such as succinimides and succinate esters; antiwear/EP additives such as tricresyl phosphate, trialkyl phosphates, trialkyl phosphites, triphenyl phosphites; antioxidants such as diphenyl amines, quinolines, phenyl alpha naphthyl amine, phenolic antioxidants; foam inhibitors such as siloxanes and low molecular methacrylates; metal passivators such as propyl gallate and benzotriazole.

A preferred lubricant base stock composition according to the invention comprises: (a) from about 30% to about 80% by weight of a poly-α-olefin having a branch ratio of greater than 0.19 and having a viscosity of from about 4 to about 8 cSt at 100°C selected from the group consisting of poly-1-octene, poly-1-nonene, poly-1-decene, poly-1-undecene, poly-1-dodecene and combinations thereof; (b) from about 1% to about 20% by weight of an ester selected from the group consisting of an aliphatic dicarboxylic acid ester wherein the alkyl group of the ester is a branched carbon chain having from about 8 to about 13 carbon atoms, a polyol ester wherein the polyol component of the ester is an aliphatic polyol having no beta hydrogen atoms and the acid component of the ester is an aliphatic branched or non-branched monocarboxylic acid having from 5 to 14 carbon atoms; (c) from about 10% to about 30% by weight of a polyisobutylene oligomer having an weight average molecular weight of from 7,500 to about 20,000 Daltons. Another preferred lubricant base stock composition according to the invention comprises: (a) from about 40% to about 80% by weight of a poly-α-olefin having a branch ratio of greater than 0.19 and having a viscosity of from about 4 to about 8 cSt at 100°C selected from the group consisting of poly-1-octene, poly-1-nonene, poly-1-decene, poly-1-undecene, poly-1-dodecene and combinations thereof; (b) from about 1% to about 20% by weight of an ester selected from the group consisting of an aliphatic dicarboxylic acid ester wherein the alkyl group of the ester is a branched carbon chain having from about 8 to about 13 carbon atoms, a polyol ester wherein the polyol component of the ester

is an aliphatic polyol having no beta hydrogen atoms and the acid component of the ester is an aliphatic monocarboxylic acid having from 5 to 14 carbon atoms; (c) from about 10% to about 30% by weight of a polyisobutylene oligomer having an weight average molecular weight of from 7,500 to about 20,000 Daltons.

The following examples are meant to illustrate but not to limit the invention.

EXAMPLE 1

PREPARATION OF DI-ISODECYLADIPATE

Di-isodecyladipate was prepared by reacting 1000 grams (1.00 equivalents) of adipic acid with 2491 grams (1.15 equivalents) of isodecyl alcohol. The reaction was carried out at 225-230°C while removing water of reaction. When the rate of water removal slowed, low vacuum was applied to help continue the reaction to an acid value of less than 3. The ester was then slowly stripped of excess alcohol by applying full vacuum of about 2 Torr. The crude ester had an acid value of 1.5 and hydroxyl value of 2.0. The crude ester was then refined and filtered to yield the following finished ester properties:

	di-isodecyladipate
Acid Value	0.016
Hydroxyl Value	1.5
Viscosity at 40°C, cst.	13.7
Viscosity at 100°C, cst.	3.5
Viscosity Index	144
Pour Point, °C	-72
Flash Point, °C	224
Fire Point, °F	252
Color % Transmission at 440/550 nm.	90/100

EXAMPLE 2

SYNTHETIC BASESTOCK ANALYSIS

	1	2
Viscosity at 40°C, cSt	25.59	26.39
Viscosity at 100°C, cSt	5.29	5.37
Viscosity Index	145	145
Pour Point, ° C	- 66	- 66
Viscosity, -40°C, cP	4900	5250

What is claimed is:

1. A base stock for a synthetic gear/transmission lubricant comprising: (a) from about 30% to about 80% by weight of a poly-α-olefin having a branch ratio of greater than 0.19 and having a viscosity of from about 4 to about 8 cSt at 100°C; (b) from about 1% to about 20% by weight of an ester having a viscosity such that a lubricant containing said base stock has a high temperature viscosity of from about 4 to about 25 cSt at 100°C and low temperature viscosity of less than about 150,000 cps at -40°C; (c) from about 10% to about 30% by weight of a polyisobutylene oligomer having a weight average molecular weight of from 7,500 to about 20,000 Daltons wherein the weight ratio of said poly-α-olefin to said ester is from about 5/1 to about 9/1.

2. The base stock of claim 1 wherein said first component is a poly-α-olefin having a viscosity of from about 4 to about 8 cSt at 100°C.

3. The base stock of claim 1 wherein said first component is a poly-α-olefin having a viscosity of from about 4 to about 6 cSt at 100°C.

4. The base stock of claim 1 wherein said ester is an aliphatic dicarboxylic acid ester wherein the alkyl group of said ester is a branched carbon chain having from about 8 to about 13 carbon atoms.

5. The base stock of claim 4 wherein said ester is a C_{8-13} branched alkyl diester of C_{4-12} aliphatic dicarboxylic acid.

6. The base stock of claim 5 wherein said dicarboxylic acid is adipic acid.

7. The base stock of claim 5 wherein said dicarboxylic acid is azelaic acid.

8. The base stock of claim 5 wherein said alkyl group is an isodecyl group.

9. The base stock of claim 1 wherein said ester is di-isodecyl adipate or di-isodecyl azelate or mixtures thereof.

10. The base stock of claim 1 wherein said ester is a polyol ester wherein the polyol component of said ester is an aliphatic polyol having no beta hydrogen atoms.

11. The base stock of claim 10 wherein said polyol is trimethylolpropane, di-trimethylolpropane, triethylolpropane, neopentyl glycol, pentaerythritol or di-pentaerythritol.

12. The base stock of claim 1 further comprising a thickener and /or viscosity index improver selected from the group consisting of an ethylene-propylene copolymer; a polymethacrylate; a polystyrene; a second poly-α-olefin having a viscosity of from about 40 to about 1,000 cSt at 100°C.

13. The base stock of claim 12 wherein said thickener and/or viscosity index improver is polyisobutylene having a weight average molecular weight of from about 1,000 to about 30,000 daltons.

14. A base stock for a synthetic gear/transmission lubricant comprising: (a) from about 30% to about 80% by weight of a poly-α-olefin having a branch ratio of greater than 0.19 and having a viscosity of from about 4 to about 8 cSt at 100°C selected from the group consisting of poly-1-octene, poly-1-nonene, poly-1-decene, poly-1-undecene, poly-1-dodecene and combinations thereof; (b) from about 1% to about 20% by weight of an ester selected from the group consisting of an aliphatic dicarboxylic acid ester wherein the alkyl group of said ester is a branched carbon chain having from about 8 to about 13 carbon atoms, a polyol ester wherein the polyol component of said ester is an aliphatic polyol having no beta hydrogen atoms and the acid component of said ester is an aliphatic branched or non-branched monocarboxylic acid having from 5 to 14 carbon atoms; (c) from about 10% to about 30% by weight of a polyisobutylene oligomer

having a weight average molecular weight of from 7,500 to about 20,000 Daltons wherein the weight ratio of said poly-α-olefin to said ester is from about 5/1 to about 9/1.

15. The base stock of claim 14 wherein said poly-α-olefin is poly-1-octene, poly-1-decene, poly-1-dodecene and combinations thereof.

16. The base stock of claim 15 wherein said poly-α-olefin is a combination of poly-1-octene and poly-1-dodecene.

17. The base stock of claim 15 wherein said poly-α-olefin is poly-1-decene.

18. The base stock of claim 14 wherein said ester is a C_{8-13} branched alkyl diester of C_{4-12} aliphatic dicarboxylic acid.

19. The base stock of claim 18 wherein said dicarboxylic acid is adipic acid.

20. The base stock of claim 18 wherein said dicarboxylic acid is azelaic acid.

21. The base stock of claim 18 wherein said alkyl group is an isodecyl group.

22. The base stock of claim 18 wherein said ester is di-isodecyl adipate or di-isodecyl azelate or mixtures thereof.

23. The base stock of claim 14 wherein said ester is a polyol ester wherein the polyol component of said ester is an aliphatic polyol having no beta hydrogen atoms and the acid component of said ester is an aliphatic monocarboxylic acid having from 5 to 14 carbon atoms.

24. The base stock of claim 22 wherein said polyol is trimethylolpropane, di-trimethylolpropane, triethylolpropane, neopentyl glycol, pentaerythritol or di-pentaerythritol.

25. The base stock of claim 14 further comprising a thickener and /or viscosity index improver selected from the group consisting of an ethylene-propylene copolymer; a polymethacrylate; a polystyrene; a second poly-α-olefin having a viscosity of from about 40 to about 1,000 cSt at 100°C.

26. The base stock of claim 25 wherein said thickener and/or viscosity index improver is polyisobutylene having a weight average molecular weight of from about 1,000 to about 30,000 Daltons.

27. A base stock for a synthetic gear/transmission lubricant comprising: (a) from about 40% to about 75% by weight of a poly-α-olefin having a branch ratio of greater than 0.19 and having a viscosity of from about 4 to about 8 cSt at 100°C selected from the group consisting of poly-1-octene, poly-1-nonene, poly-1-decene, poly-1-undecene, poly-1-dodecene and combinations thereof; (b) from about 1% to about 15% by weight of an ester selected from the group consisting of an aliphatic dicarboxylic acid ester wherein the alkyl group of said ester is a branched carbon chain having from about 8 to about 13 carbon atoms, a polyol ester wherein the polyol component of said ester is an aliphatic polyol having no beta hydrogen atoms and the acid component of said ester is an aliphatic monocarboxylic acid having from 5 to 14 carbon atoms; (c) from about 10% to about 30% by weight of a polyisobutylene oligomer having a weight average molecular weight of from 7,500 to about 20,000 Daltons wherein the weight ratio of said poly-α-olefin to said ester is from about 5/1 to about 9/1.

28. The base stock of claim 27 wherein said poly-α-olefin is poly-1-octene, poly-1-decene, poly-1-dodecene and combinations thereof.

29. The base stock of claim 27 wherein said poly-α-olefin is a combination of poly-1-octene and poly-1-dodecene.

30. The base stock of claim 27 wherein said poly-α-olefin is poly-1-decene.

31. The base stock of claim 27 wherein the amount of said poly-α-olefin is from about 50 to about 75% by weight.

32. The base stock of claim 27 wherein the amount of said ester is from about 1 to about 20% by weight.

33. The base stock of claim 27 wherein said ester is di-isodecyl adipate or diisodecylazelate or mixtures thereof.

34. The base stock of claim 27 further comprising a thickener and or viscosity index improver selected from the group consisting of an ethylene-propylene copolymer; a polymethacrylate; a polystyrene; a second poly-α-olefin having a viscosity of from about 40 to about 1,000 cSt at 100°C.

35. The base stock of claim 34 wherein said thickener and/or viscosity index improver is polyisobutylene having a weight average molecular weight of from about 1,000 to about 30,000 Daltons.

36 A process for lubricating gears comprising contacting one or more gears with a lubricating-effective amount of the base stock of claim 1.

37. A process for lubricating gears comprising contacting one or more gears with a lubricating-effective amount of the base stock of claim 14.

38. A process for lubricating gears comprising contacting one or more gears with a lubricating-effective amount of the base stock of claim 27.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/11921

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :C10M 107/00, 129/72, 143/06
US CL :508/485, 496, 499

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 508/485, 496, 499

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,180,865 A (HEILMAN ET AL) 19 January 1993,column 1, line 67 bridging column 2, lines 1-2; column 3, lines 51-55; column 4, lines 43-56; Table 1; Example 1; Table 5.	1 - 6 , 1 2 - 18,20,25,26,36,37
Y	US 4,992,183 A (BEIMESCH ET AL) 12 February 1991, column 8, lines 31-56.	7-11,19,21-24,27-35,38

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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