ENGINE OIL FORMULATION WITH IMPROVED SEQUENCE VIII PERFORMANCE

TECHNICAL FIELD

[0001] The disclosure relates to engine lubricating oils improved Sequence VIII performance. In particular, this disclosure relates to lubricating oils, and methods for improving viscosity shear stability of a lubricating oil in an engine or other mechanical components lubricated with the lubricating oil. The lubricating oils of this disclosure are useful as internal combustion engine oils or other applications where lubricating oils are subjected to heat and oxidative conditions.

BACKGROUND

[0002] Lubricating oils are an essential part of modern vehicle design for engine operation and protection. One essential feature of engine oil is the viscosity, which must be viscous enough to lubricate effectively without being so viscous that the engine cannot effectively distribute the fluid to parts of the engine that need lubrication. Viscosity is closely linked to fuel economy, with higher viscosity detracting from fuel efficiency.

[0003] In addition, the shear-resistance of the lubricant is very important. The oil drain intervals of lubricating oils are getting longer which requires more shear-resistant lubricants. Further, since the viscosity of fresh lubricant is very low, further reduction of the viscosity due to shear-losses might cause a failure of the metal parts. This is due to the high-temperature and severe service conditions these lubricants are subject to in spark-ignition engines. What is needed is a newly designed additive package for lubricants capable of controlling viscosity shear stability for longer periods of time as compared to conventional additive packages.

SUMMARY AND TERMS

[0004] The present disclosure may be described by the following sentences.

1. In a first example, the present disclosure relates to a lubricating oil composition comprising:

greater than 50 wt.% of a base oil of lubricating viscosity;

an amount of one or more zinc dialkyl dithiophosphate compound(s);

wherein the lubricating oil composition has a ratio of $KV40^{o}C_{fresh}$ to a weight % of zinc contributed by the one or more zinc dialkyl dithiophosphate compound(s) based on a total weight of the lubricating oil composition, of greater than 510, wherein $KV40^{o}C_{fresh}$ is the kinematic viscosity of the fresh lubricating oil composition at 40ºC as measured by ASTM D445.

selected from the group consisting of isopropyl alcohol, amyl alcohol, and methyl isobutyl carbinol.

10. The lubricating oil composition of any one of the preceding sentences, wherein the one or more zinc dialkyl dithiophosphate compound(s) may be derived from one or more primary alkyl alcohol(s) and one or more secondary alkyl alcohol(s).

11. The lubricating oil composition of any one of the preceding sentences, may further comprise one or more calcium-containing detergent(s), present in an amount to provide from about 800 ppm of calcium to 3000 ppm of calcium, or from about 900 ppm of calcium to about 2800 ppm of calcium, based on a total weight of the lubricating oil composition.

12. The lubricating oil composition of sentence 11, wherein the one or more calcium-containing detergent(s) may comprise an overbased calcium-containing detergent having a total base number of about 200 mg KOH/g or greater, or about 225 mg KOH/g or greater, or about 250 mg KOH/gram or greater, or about 300 mg KOH/g or greater.

13. The lubricating oil composition of sentence 12, wherein the one or more calcium-containing detergent(s) may comprise a detergent selected from a calcium sulfonate detergent, a calcium phenate detergent, or combinations thereof.

14. The lubricating oil composition of any one of the preceding sentences, may further comprise a viscosity index improver.

15. The lubricating oil composition of sentence 14, wherein the viscosity index improver may be a copolymer of ethylene-propylene having an average molecule weight of from 50,000 to 500,000, as measured by gel permeation chromatography.

17. The lubricating oil composition of any one of the preceding sentences, may further comprise a nitrogen-containing dispersant present in an amount to provide from about 50 ppmw to about 1000 ppmw or from about 100 ppmw to about 900 ppmw.

18. In a second example, the present disclosure relates to a lubricating oil composition comprising:

greater than 50 wt.% of a base oil of lubricating viscosity;

500,000, as measured by gel permeation chromatography.

33. The lubricating oil composition of any one of sentences 18 – 32, may further comprise a nitrogen-containing dispersant present in an amount to provide from about 50 ppmw to about 1000 ppmw or from about 100 ppmw to about 900 ppmw.

34. In a third example, the present disclosure relates to a lubricating oil composition comprising:

greater than 50 wt.% of a base oil of lubricating viscosity;

an amount of one or more zinc dialkyl dithiophosphate compound(s);

wherein the lubricating oil composition has one or both of the following ratios:

a) a ratio of $KV40^{o}C_{fresh}$ to a weight % of zinc contributed by the one or more zinc dialkyl dithiophosphate compound(s) based on a total weight of the lubricating oil composition, of greater than 510, wherein $KV40^{o}C_{fresh}$ is the kinematic viscosity of the fresh lubricating oil composition at 40ºC as measured by ASTM D445; and

b) a ratio of $KV40^{o}C_{fresh}$ to a weight % of phosphorus contributed by the one or more zinc dialkyl dithiophosphate compound(s) based on a total weight of the lubricating oil composition, of greater than 560, wherein $KV40^{o}C_{fresh}$ is the kinematic viscosity of the fresh lubricating oil composition at 40ºC as measured by ASTM D445.

35. In a fourth example, the present disclosure relates to a method of improving the viscosity shear stability of a lubricating oil in an engine, the method comprising adding to the engine the lubricating oil composition of any one of sentences 1 – 34.

[0004a] In one aspect, the present disclosure refers to an automotive engine oil composition comprising:

greater than 50 wt.% of a base oil of lubricating viscosity;

an amount of one or more zinc dialkyl dithiophosphate compound(s);

one or more viscosity index improvers present in an amount of greater than 5.0 wt.%, based on a total weight of the automotive engine oil composition;

wherein the automotive engine oil composition has a ratio of $KV40^{o}C_{fresh}$ to a weight % of zinc contributed by the one or more zinc dialkyl dithiophosphate compound(s) based on a total weight of the automotive engine oil composition, of greater than 510, wherein $KV40^{o}C_{fresh}$ is the kinematic viscosity of fresh automotive engine oil composition at 40ºC as measured by ASTM D445,

and the automotive engine oil composition has a $KV100^{o}C_{sheared}$ of greater than or equal to 8.0 cSt, wherein $KV100^{o}C_{sheared}$ is the kinematic viscosity of the automotive engine oil composition after being stripped for 10 hours at 100ºC, as measured by ASTM D445, and the $KV40^{o}C_{fresh}$ is greater than 40 cSt, as measured by ASTM D445.

[0004b] In one aspect, the present disclosure refers to an automotive engine oil composition comprising:

greater than 50 wt.% of a base oil of lubricating viscosity;

an amount of one or more zinc dialkyl dithiophosphate compound(s);

one or more viscosity index improvers present in an amount of greater than 5.0 wt.%, based on a total weight of the automotive engine oil composition;

wherein the automotive engine oil composition has a ratio of $KV40^{o}C_{fresh}$ to a weight % of phosphorus contributed by the one or more zinc dialkyl dithiophosphate compound(s) based on a total weight of the automotive engine oil composition, of greater than 560, wherein $KV40^{o}C_{fresh}$ is the kinematic viscosity of the fresh automotive engine oil composition at 40ºC as measured by ASTM D445,

and the automotive engine oil composition has a $KV100^{o}C_{sheared}$ of greater than or equal to 8.0 cSt, wherein $KV100^{o}C_{sheared}$ is the kinematic viscosity of the automotive engine oil composition after being stripped for 10 hours at 100ºC, as measured by ASTM D445, and the $KV40^{o}C_{fresh}$ is greater than 40 cSt, as measured by ASTM D445.

[0004c] In one aspect, the present disclosure refers to an automotive engine oil composition comprising:

greater than 50 wt.% of a base oil of lubricating viscosity;

an amount of one or more zinc dialkyl dithiophosphate compound(s);

one or more viscosity index improvers present in an amount of greater than 5.0 wt.%, based on a total weight of the automotive engine oil composition;

wherein the automotive engine oil composition has a $KV100^{o}C_{sheared}$ of greater than or equal to 8.0 cSt, wherein $KV100^{o}C_{sheared}$ is the kinematic viscosity of the automotive engine oil composition after being stripped for 10 hours at 100ºC, as measured by ASTM D445, and a $KV40^{o}C_{fresh}$ is greater than 40 cSt, as measured by ASTM D445 and

the automotive engine oil composition has both of the following ratios:

a) a ratio of $KV40^{o}C_{fresh}$ to a weight % of zinc contributed by the one or more zinc dialkyl dithiophosphate compound(s) based on a total weight of the automotive

engine oil composition, of greater than 510, wherein $KV40^{o}C_{fresh}$ is the kinematic viscosity of the fresh automotive engine oil composition at 40ºC as measured by ASTM D445; and

b) a ratio of $KV40^{o}C_{fresh}$ to a weight % of phosphorus contributed by the one or more zinc dialkyl dithiophosphate compound(s) based on a total weight of the automotive engine oil composition, of greater than 560, wherein $KV40^{o}C_{fresh}$ is the kinematic viscosity of the fresh automotive engine oil composition at 40ºC as measured by ASTM D445.

[0005] The following definitions of terms are provided in order to clarify the meanings of certain terms as used herein.

[0006] The terms "oil composition," "lubrication composition," "lubricating oil composition," "lubricating oil," "lubricant composition," "lubricating composition," "fully formulated lubricant composition," "lubricant," "crankcase oil," "crankcase lubricant," "engine oil," "engine lubricant," "motor oil," and "motor lubricant" are considered synonymous, fully interchangeable terminology referring to the finished lubrication product comprising a major amount of a base oil plus a minor amount of an additive composition.

[0007] As used herein, the terms "additive package," "additive concentrate," "additive composition," "engine oil additive package," "engine oil additive concentrate," "crankcase additive package," "crankcase additive concentrate," "motor oil additive package," "motor oil concentrate," are considered synonymous, fully interchangeable terminology referring the

coating, a graphite coating, a nano-particle-containing coating, and/or mixtures thereof. The aluminum-alloy may include aluminum silicates, aluminum oxides, or other ceramic materials. In one example the aluminum-alloy is an aluminum-silicate surface. As used herein, the term "aluminum alloy" is intended to be synonymous with "aluminum composite" and to describe a component or surface comprising aluminum and another component intermixed or reacted on a microscopic or nearly microscopic level, regardless of the detailed structure thereof. This would include any conventional alloys with metals other than aluminum as well as composite or alloy-like structures with non-metallic elements or compounds such with ceramic-like materials.

[0019] The lubricating oil composition for an internal combustion engine may be suitable for any engine lubricant irrespective of the sulfur, phosphorus, or sulfated ash (ASTM D-874) content. The sulfur content of the engine oil lubricant may be about 1 wt.% or less, or about 0.8 wt.% or less, or about 0.5 wt.% or less, or about 0.3 wt.% or less, or about 0.2 wt.% or less. In one example the sulfur content may be in the range of about 0.001 wt.% to about 0.5 wt.%, or about 0.01 wt.% to about 0.3 wt.%. The phosphorus content may be about 0.2 wt.% or less, or about 0.1 wt.% or less, or about 0.085 wt.% or less, or about 0.08 wt.% or less, or even about 0.06 wt.% or less, about 0.055 wt.% or less, or about 0.05 wt.% or less. In one example the phosphorus content may be about 50 ppm to about 1000 ppm, or about 325 ppm to about 850 ppm. The total sulfated ash content may be about 2 wt.% or less, or about 1.5 wt.% or less, or about 1.1 wt.% or less, or about 1 wt.% or less, or about 0.8 wt.% or less, or about 0.5 wt.% or less. In one example the sulfated ash content may be about 0.05 wt.% to about 0.9 wt.%, or about 0.1 wt.% or about 0.2 wt.% to about 0.45 wt.%. In another example, the sulfur content may be about 0.4 wt.% or less, the phosphorus content may be about 0.08 wt.% or less, and the sulfated ash is about 1 wt.% or less. In yet another example the sulfur content may be about 0.3 wt.% or less, the phosphorus content is about 0.05 wt.% or less, and the sulfated ash may be about 0.8 wt.% or less.

[0020] In one example the lubricating oil composition is an engine oil, wherein the lubricating oil composition may have (i) a sulfur content of about 0.5 wt.% or less, (ii) a phosphorus content of about 0.1 wt.% or less, and (iii) a sulfated ash content of about 1.5 wt.% or less.

[0021] In one example the lubricating oil composition is suitable for a 2-stroke or a 4-stroke marine diesel internal combustion engine. In one example the marine diesel combustion engine is a 2-stroke engine. In some examples, the lubricating oil composition is not suitable for a 2-stroke or a 4-stroke marine diesel internal combustion engine for one or more reasons, including but not limited to, the high sulfur content of fuel used in powering a marine

engine and the high TBN required for a marine-suitable engine oil (e.g., above about 40 TBN in a marine-suitable engine oil).

[0022] In some examples, the lubricating oil composition is suitable for use with engines powered by low sulfur fuels, such as fuels containing about 1 to about 5% sulfur. Highway vehicle fuels contain about 15 ppm sulfur (or about 0.0015% sulfur).

[0023] Low speed diesel typically refers to marine engines, medium speed diesel typically refers to locomotives, and high speed diesel typically refers to highway vehicles. The lubricating oil composition may be suitable for only one of these types or all.

[0024] Further, lubricants of the present description may be suitable to meet one or more industry specification requirements such as ILSAC GF-3, GF-4, GF-5, GF-5+, GF-6, PC-11, CF, CF-4, CH-4, CK-4, FA-4, CJ-4, CI-4 Plus, CI-4, API SG, SJ, SL, SM, SN, SN PLUS, ACEA A1/B1, A2/B2, A3/B3, A3/B4, A5/B5, A7/B7, C1, C2, C3, C4, C5, C6 E4/E6/E7/E9, Euro 5/6, JASO DL-1, Low SAPS, Mid SAPS, or original equipment manufacturer specifications such as Dexos1™, Dexos2™, MB-Approval 229.1, 229.3, 229.5, 22.51/229.31, 229.52, 229.6, 229.71, 226.5, 226.51, 228.0/.1, 228.2/.3, 228.31, 228.5, 228.51, 228.61, VW 501.01, 502.00, 503.00/503.01, 504.00, 505.00, 505.01, 506.00/506.01, 507.00, 508.00, 509.00, 508.88, 509.99, BMW Longlife-01, Longlife-01 FE, Longlife-04, Longlife-12 FE, Longlife-14 FE+, Longlife-17 FE+ Porsche A40, C30, Peugeot Citroën Automobiles B71 2290, B71 2294, B71 2295, B71 2296, B71 2297, B71 2300, B71 2302, B71 2312, B71 2007, B71 2008, Renault RN0700, RN0710, RN0720, Ford WSS-M2C153-H, WSS-M2C930-A, WSS-M2C945-A, WSS-M2C913A, WSS-M2C913-B, WSS-M2C913-C, WSS-M2C913-D, WSS-M2C948-B, WSS-M2C948-A, GM 6094-M, Chrysler MS-6395, Fiat 9.55535 G1, G2, M2, N1, N2, Z2, S1, S2, S3, S4, T2, DS1, DSX, GH2, GS1, GSX, CR1, Jaguar Land Rover STJLR.03.5003, STJLR.03.5004, STJLR.03.5005, STJLR.03.5006, STJLR.03.5007, STJLR.51.5122, or any past or future PCMO or HDD specifications not mentioned herein. In some examples for passenger car motor oil (PCMO) applications, the amount of phosphorus in the finished fluid is 1000 ppm or less or 900 ppm or less or 800 ppm or less.

[0025] Other hardware may not be suitable for use with the disclosed lubricant. A "functional fluid" is a term which encompasses a variety of fluids including but not limited to tractor hydraulic fluids, power transmission fluids including automatic transmission fluids, continuously variable transmission fluids and manual transmission fluids, hydraulic fluids, including tractor hydraulic fluids, some gear oils, power steering fluids, fluids used in wind turbines, compressors, some industrial fluids, and fluids related to power train components. It should be noted that within each of these fluids such as, for example, automatic transmission

fluids, there are a variety of different types of fluids due to the various transmissions having different designs which have led to the need for fluids of markedly different functional characteristics. This is contrasted by the term “lubricating fluid” which is not used to generate or transfer power.

[0026] With respect to tractor hydraulic fluids, for example, these fluids are all-purpose products used for all lubricant applications in a tractor except for lubricating the engine. These lubricating applications may include lubrication of gearboxes, power take-off and clutch(es), rear axles, reduction gears, wet brakes, and hydraulic accessories.

[0027] When the functional fluid is an automatic transmission fluid, the automatic transmission fluids must have enough friction for the clutch plates to transfer power. However, the friction coefficient of fluids has a tendency to decline due to the temperature effects as the fluid heats up during operation. It is important that the tractor hydraulic fluid or automatic transmission fluid maintain its high friction coefficient at elevated temperatures, otherwise brake systems or automatic transmissions may fail. This is not a function of an engine oil.

[0028] Tractor fluids, and for example Super Tractor Universal Oils (STUOs) or Universal Tractor Transmission Oils (UTTOs), may combine the performance of engine oils with transmissions, differentials, final-drive planetary gears, wet-brakes, and hydraulic performance. While many of the additives used to formulate a UTTO or a STUO fluid are similar in functionality, they may have deleterious effect if not incorporated properly. For example, some anti-wear and extreme pressure additives used in engine oils can be extremely corrosive to the copper components in hydraulic pumps. Detergents and dispersants used for gasoline or diesel engine performance may be detrimental to wet brake performance. Friction modifiers specific to quiet wet brake noise, may lack the thermal stability required for engine oil performance. Each of these fluids, whether functional, tractor, or lubricating, are designed to meet specific and stringent manufacturer requirements.

[0029] The present disclosure provides novel lubricating oil blends formulated for use as automotive crankcase lubricants. The present disclosure provides novel lubricating oil blends formulated for use as 2T and/or 4T motorcycle crankcase lubricants. Examples of the present disclosure may provide lubricating oils suitable for crankcase applications and having improvements in the following characteristics: air entrainment, alcohol fuel compatibility, antioxidancy, antiwear performance, biofuel compatibility, foam reducing properties, friction reduction, fuel economy, preignition prevention, rust inhibition, sludge and/or soot dispersability, piston cleanliness, deposit formation, and water tolerance.

CLAIMS

1. An automotive engine oil composition comprising:

greater than 50 wt.% of a base oil of lubricating viscosity;

an amount of one or more zinc dialkyl dithiophosphate compound(s);

one or more viscosity index improvers present in an amount of greater than 5.0 wt.%, based on a total weight of the automotive engine oil composition;

wherein the automotive engine oil composition has a ratio of $KV40^{o}C_{fresh}$ to a weight % of zinc contributed by the one or more zinc dialkyl dithiophosphate compound(s) based on a total weight of the automotive engine oil composition, of greater than 510, wherein $KV40^{o}C_{fresh}$ is the kinematic viscosity of fresh automotive engine oil composition at 40ºC as measured by ASTM D445,

and the automotive engine oil composition has a $KV100^{o}C_{sheared}$ of greater than or equal to 8.0 cSt, wherein $KV100^{o}C_{sheared}$ is the kinematic viscosity of the automotive engine oil composition after being stripped for 10 hours at 100ºC, as measured by ASTM D445, and the $KV40^{o}C_{fresh}$ is greater than 40 cSt, as measured by ASTM D445.

2. The automotive engine oil composition of claim 1, wherein the amount of zinc provided by the one or more zinc dialkyl dithiophosphate compound(s) is less than 1500 ppm, based on a total weight of the automotive engine oil composition.

3. The automotive engine oil composition of claim 1, wherein the one or more zinc dialkyl dithiophosphate compound(s) is derived from one or more primary alkyl alcohol(s), one or more secondary alkyl alcohol(s), or combinations thereof.

4. The automotive engine oil composition of claim 1, wherein the one or more zinc dialkyl dithiophosphate compound(s) is derived from one or more primary alkyl alcohol(s) each having an alkyl group with 3 to 8 carbon atoms.

5. The automotive engine oil composition of claim 1, wherein the one or more zinc dialkyl dithiophosphate compound(s) is derived from one or more primary alkyl alcohol(s) selected from the group consisting of n-propyl alcohol, isopropyl alcohol, isobutyl alcohol, n-butyl alcohol, 2-butanol, n-pentyl alcohol, hexanol, methyl isobutyl carbinol, isohexanol, n-heptanol, isoheptanol, octanol, amyl alcohol, and 2-ethylhexanol.

6. The automotive engine oil composition of claim 1, wherein the one or more zinc dialkyl dithiophosphate compound(s) is derived from one or more secondary alkyl alcohol(s) having an alkyl group with 3 to 8 carbon atoms.

7. The automotive engine oil composition of claim 1, wherein the one or more zinc dialkyl dithiophosphate compound(s) is derived from a secondary alkyl alcohol selected from the group consisting of isopropyl alcohol, amyl alcohol, and methyl isobutyl carbinol.

8. The automotive engine oil composition of claim 1, wherein the one or more zinc dialkyl dithiophosphate compound(s) is derived from one or more primary alkyl alcohol(s) and one or more secondary alkyl alcohol(s).

9. The automotive engine oil composition of claim 1, further comprising a combination of an overbased calcium sulfonate detergent and an overbased calcium phenate detergent, wherein said combination provides from 800 ppm of calcium to 3000 ppm of calcium, based on a total weight of the automotive engine oil composition,

the overbased calcium sulfonate detergent and the overbased calcium phenate detergent each have a total base number of 200 mg KOH/g or greater, and

the one or more zinc dialkyl dithiophosphate compound(s) is derived from one or more secondary alkyl alcohol(s) having an alkyl group with 3 to 8 carbon atoms.

10. The automotive engine oil composition of claim 1, wherein the viscosity index improver is a copolymer of ethylene-propylene having an average molecule weight of from 50,000 to 500,000, as measured by gel permeation chromatography.

11. The automotive engine oil composition of claim 1, further comprising a nitrogen-containing dispersant present in an amount to provide from 50 ppmw to 1000 ppmw of nitrogen to the automotive engine oil composition, based on the total weight of the automotive engine oil composition.

12. An automotive engine oil composition comprising:

greater than 50 wt.% of a base oil of lubricating viscosity;

an amount of one or more zinc dialkyl dithiophosphate compound(s);

one or more viscosity index improvers present in an amount of greater than 5.0 wt.%, based on a total weight of the automotive engine oil composition;

wherein the automotive engine oil composition has a ratio of $KV40^{o}C_{fresh}$ to a weight % of phosphorus contributed by the one or more zinc dialkyl dithiophosphate compound(s) based on a total weight of the automotive engine oil composition, of greater than 560, wherein $KV40^{o}C_{fresh}$ is the kinematic viscosity of the fresh automotive engine oil composition at 40ºC as measured by ASTM D445,

and the automotive engine oil composition has a $KV100^{o}C_{sheared}$ of greater than or equal to 8.0 cSt, wherein $KV100^{o}C_{sheared}$ is the kinematic viscosity of the automotive engine oil composition after being stripped for 10 hours at 100ºC, as measured by ASTM D445, and the $KV40^{o}C_{fresh}$ is greater than 40 cSt, as measured by ASTM D445.

13. An automotive engine oil composition comprising:

greater than 50 wt.% of a base oil of lubricating viscosity;

an amount of one or more zinc dialkyl dithiophosphate compound(s);

one or more viscosity index improvers present in an amount of greater than 5.0 wt.%, based on a total weight of the automotive engine oil composition;

wherein the automotive engine oil composition has a $KV100^{o}C_{sheared}$ of greater than or equal to 8.0 cSt, wherein $KV100^{o}C_{sheared}$ is the kinematic viscosity of the automotive engine oil composition after being stripped for 10 hours at 100ºC, as measured by ASTM D445, and a $KV40^{o}C_{fresh}$ is greater than 40 cSt, as measured by ASTM D445 and

the automotive engine oil composition has both of the following ratios:

a) a ratio of $KV40^{o}C_{fresh}$ to a weight % of zinc contributed by the one or more zinc dialkyl dithiophosphate compound(s) based on a total weight of the automotive engine oil composition, of greater than 510, wherein $KV40^{o}C_{fresh}$ is the kinematic viscosity of the fresh automotive engine oil composition at 40ºC as measured by ASTM D445; and

b) a ratio of $KV40^{o}C_{fresh}$ to a weight % of phosphorus contributed by the one or more zinc dialkyl dithiophosphate compound(s) based on a total weight of the automotive engine oil composition, of greater than 560, wherein $KV40^{o}C_{fresh}$ is the kinematic viscosity of the fresh automotive engine oil composition at 40ºC as measured by ASTM D445.

14. A method of improving the viscosity shear stability of a lubricating oil in an automotive engine, the method comprising adding to a crankcase of the automotive engine the automotive engine oil composition of claim 13.