SUMMARY AND TERMS

[0005] The present disclosure meets the above-described need in the art for a lubricant composition having a desirable viscosity profile, including good low-temperature viscosity characteristics. The present disclosure also meets the need for a lubricant composition which exhibits good dispersancy properties without requiring a high dispersant treat rate, as is typically associated with a high performance engine oil.

[0005a] In one aspect, the present disclosure refers to a lubricating oil composition comprising greater than 50 wt.% of a base oil of lubricating viscosity, and an additive composition comprising:

one or more zinc dialkyl dithiophosphates (ZDDP compounds), one or more dispersants present in an amount of from about 0.1 wt.% to about 7 wt.%, based on a total weight of the lubricating oil composition, wherein the one or more dispersants consist of dispersants derived from polyisobutylene succinic anhydride (PIBSA), each of the one or more dispersants have a TBN of from 10 mg KOH/g to 65 mg KOH/g, measured by the method of ASTM D2896, and the TBN of the total dispersant in the lubricating oil composition is at least 0.79 mg KOH/g to 2.5 mg KOH/g, and

one or more calcium-containing detergents present in an amount to provide greater than 0.01 wt.% calcium to 0.25 wt.% calcium, based on a total weight of the lubricating oil composition, and

wherein the amount of zinc (Zn) in weight percent provided to the lubricating oil composition by the one or more ZDDP compounds multiplied by the total base number (TBN) of the one or more dispersants derived from PIBSA in the lubricating oil composition is a multiplication factor Zn*TBNDisp of at least 0.06.

[0005b] In one aspect, the present disclosure refers to a lubricating oil composition comprising greater than 50 wt.% of a base oil of lubricating viscosity, and an additive composition comprising:

one or more zinc dialkyl dithiophosphates (ZDDP compounds),

one or more dispersants present in an amount of from about 0.1 wt.% to about 7 wt.%, based on a total weight of the lubricating oil composition, wherein the one or more dispersants consist of dispersants derived from polyisobutylene succinic anhydride (PIBSA), each of the one or more dispersants have a TBN of from 10 mg KOH/g to 65 mg KOH/g, measured by the method of ASTM D2896, and the TBN of the total dispersant in the lubricating oil composition is at least 0.79 mg KOH/g to 2.5 mg KOH/g, and

one or more calcium-containing detergents are present in an amount to provide greater than 0.01 wt.% calcium to 0.25 wt.%, based on a total weight of the lubricating oil composition, and

wherein the amount of phosphorus (P) in weight percent provided to the lubricating oil composition by the one or more ZDDP compounds multiplied by the total base number (TBN) of the one or more dispersants derived from PIBSA in the lubricating oil composition is a multiplication factor P*TBNDisp of at least 0.051.

[0005c] In one aspect, the present disclosure refers to a method of reducing engine sludge of an internal combustion engine, the method comprising adding to the engine the lubricating oil composition disclosed herein and operating said engine, wherein the lubricating oil composition provides results of an Average Engine Sludge test (ASTM D8256) of 7.01 minutes or higher.

[0005d] In one aspect, the present disclosure refers to a method of improving the fuel economy performance and/or piston cleanliness performance of an engine and/or a vehicle, comprising the step of providing the engine and/or the vehicle with a lubricant composition disclosed herein.

[0006] 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, and an additive composition comprising:

one or more zinc dialkyl dithiophosphates (ZDDP compounds) and one or more dispersants, wherein the amount of zinc (Zn) in weight percent provided to the lubricating oil composition by the one or more ZDDP compounds multiplied by the contribution of the total base number (TBN) of the one or more dispersants to the TBN of the lubricating oil composition is a multiplication factor Zn*TBNDisp of at least about 0.06.

2. The lubricating oil composition of sentence 1, wherein the Zn*TBNDisp multiplication factor may be more than about 0.07; or about 0.07 to 0.4; or about 0.075 to about 0.2.

3. The lubricating oil composition of any one of the previous sentences, wherein the Zn*TBNDisp multiplication factor may be at least about 0.06 and the one or more ZDDP compounds is present in a sufficient amount to provide greater than about 0.071 wt.% of zinc based on the total weight of the lubricating oil composition; or the Zn*TBNDisp multiplication factor is more than about 0.07 and the one or more ZDDP compounds is present in a sufficient amount to provide greater than about 0.080 wt.% of zinc based on the total weight of the lubricating oil composition.

4. The lubricating oil composition of any one of the previous sentences, wherein the Zn*TBNDisp multiplication factor may be at least about 0.06 and the contribution of TBN of the one or more dispersants to the TBN of the lubricating oil composition is at least 0.79 mg KOH/g; or the Zn*TBNDisp multiplication factor is more than about 0.07 and the

contribution of TBN of the one or more dispersants to the TBN of the lubricating oil composition is at least 0.85 mg KOH/g.

5. 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, and an additive composition comprising:

one or more zinc dialkyl dithiophosphates (ZDDP compounds) and one or more dispersants, wherein the amount of phosphorus (P) in weight percent provided to the lubricating oil composition by the one or more ZDDP compounds multiplied by the contribution of the total base number (TBN) of the one or more dispersants to the TBN of the lubricating oil composition is a multiplication factor P*TBNDisp of at least about 0.051.

6. The lubricating oil composition of sentence 5, wherein the P*TBNDisp multiplication factor may be more than about 0.06 to 0.5; or about 0.07 to about 0.25.

7. The lubricating oil composition of any one of sentences 5-6, wherein the P*TBNDisp multiplication factor may be at least about 0.051 and the one or more ZDDP compounds is present in a sufficient amount to provide greater than about 0.065 wt.% of P based on the total weight of the lubricating oil composition; or the P*TBNDisp multiplication factor is more than about 0.06 to 0.5 and the one or more ZDDP compounds is present in a sufficient amount to provide greater than about 0.07 wt.% of P based on the total weight of the lubricating oil composition.

8. The lubricating oil composition of any one of sentences 5-7, wherein the P*TBNDisp multiplication factor may be at least about 0.051 and the contribution of TBN of the one or more dispersants to the TBN of the lubricating oil composition is at least 0.79 mg KOH/g; or the P*TBNDisp multiplication factor is more than about 0.06 to 0.5 and the contribution of TBN of the one or more dispersants to the TBN of the lubricating oil composition is at least 0.85 mg KOH/g.

9. The lubricating oil composition of any one of sentences 1-4, wherein the one or more ZDDP compounds may be present in the lubricating oil composition in amounts of from about 0.01 wt.% to about 15 wt.%, or about 0.1 wt.% to about 10 wt.%, or about 0.5 wt.% to

[0015] The term "TBN" as employed herein is used to denote the Total Base Number in mg KOH/g as measured by the method of ASTM D2896 or ASTM D4739 or DIN 51639-1.

[0016] The term "alkyl" as employed herein refers to straight, branched, cyclic, and/or substituted saturated chain moieties of from about 1 to about 100 carbon atoms.

[0017] The term "alkenyl" as employed herein refers to straight, branched, cyclic, and/or substituted unsaturated chain moieties of from about 3 to about 10 carbon atoms.

[0018] The term “aryl” as employed herein refers to single and multi-ring aromatic compounds that may include alkyl, alkenyl, alkylaryl, amino, hydroxyl, alkoxy, halo substituents, and/or heteroatoms including, but not limited to, nitrogen, oxygen, and sulfur.

[0019] Lubricants, combinations of components, or individual components of the present description may be suitable for use in various types of internal combustion engines. Suitable engine types may include, but are not limited to heavy duty diesel, passenger car, light duty diesel, medium speed diesel, or marine engines. An internal combustion engine may be a diesel fueled engine, a gasoline fueled engine, a natural gas fueled engine, a bio-fueled engine, a mixed diesel/biofuel fueled engine, a mixed gasoline/biofuel fueled engine, an alcohol fueled engine, a mixed gasoline/alcohol fueled engine, a compressed natural gas (CNG) fueled engine, or mixtures thereof. A diesel engine may be a compression ignited engine. A gasoline engine may be a spark-ignited engine. An internal combustion engine may also be used in combination with an electrical or battery source of power. An engine so configured is commonly known as a hybrid engine. The internal combustion engine may be a 2-stroke, 4-stroke, or rotary engine. Suitable internal combustion engines include marine diesel engines (such as inland marine), aviation piston engines, low-load diesel engines, and motorcycle, automobile, locomotive, and truck engines.

[0020] The internal combustion engine may contain components of one or more of an aluminum-alloy, lead, tin, copper, cast iron, magnesium, ceramics, stainless steel, composites, and/or mixtures thereof. The components may be coated, for example, with a diamond-like carbon coating, a lubrited coating, a phosphorus-containing coating, molybdenum-containing 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.

[0021] 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 0.06 wt.% to about 0.2 wt.%. In one example the phosphorus content may be about 500 ppmw to about 1250 ppmw, or about 600 ppmw to about 1200 ppmw. 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 0.12 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 0.11 wt.% or less, and the sulfated ash may be about 0.8 wt.% or less.

[0022] 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.

[0023] 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).

[0024] 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 ppmw sulfur (or about 0.0015% sulfur).

[0025] 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.

[0026] 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 ppmw or less or 900 ppmw or less or 800 ppmw or less.

[0027] 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.

[0028] 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.

[0029] 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.

[0030] 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.

[0031] 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, anti-wear performance, biofuel compatibility, foam reducing

What is Claimed is:

1. A lubricating oil composition comprising greater than 50 wt.% of a base oil of lubricating viscosity, and an additive composition comprising:

one or more zinc dialkyl dithiophosphates (ZDDP compounds), one or more dispersants present in an amount of from about 0.1 wt.% to about 7 wt.%, based on a total weight of the lubricating oil composition, wherein the one or more dispersants consist of dispersants derived from polyisobutylene succinic anhydride (PIBSA), each of the one or more dispersants have a TBN of from 10 mg KOH/g to 65 mg KOH/g, measured by the method of ASTM D2896, and the TBN of the total dispersant in the lubricating oil composition is at least 0.79 mg KOH/g to 2.5 mg KOH/g, and

one or more calcium-containing detergents present in an amount to provide greater than 0.01 wt.% calcium to 0.25 wt.% calcium, based on a total weight of the lubricating oil composition, and

wherein the amount of zinc (Zn) in weight percent provided to the lubricating oil composition by the one or more ZDDP compounds multiplied by the total base number (TBN) of the one or more dispersants derived from PIBSA in the lubricating oil composition is a multiplication factor Zn*TBNDisp of at least 0.06.

2. The lubricating oil composition of claim 1, wherein the Zn*TBNDisp multiplication factor is more than 0.07.

3. The lubricating oil composition of claim 1, wherein the Zn*TBNDisp multiplication factor is at least 0.06 and the one or more ZDDP compounds is present in a sufficient amount to provide greater than 0.071 wt.% of zinc based on the total weight of the lubricating oil composition.

4. A lubricating oil composition comprising greater than 50 wt.% of a base oil of lubricating viscosity, and an additive composition comprising:

one or more zinc dialkyl dithiophosphates (ZDDP compounds),

one or more dispersants present in an amount of from about 0.1 wt.% to about 7 wt.%, based on a total weight of the lubricating oil composition, wherein the one or more dispersants consist of dispersants derived from polyisobutylene succinic anhydride (PIBSA), each of the one or more dispersants have a TBN of from 10 mg KOH/g to 65 mg KOH/g,

measured by the method of ASTM D2896, and the TBN of the total dispersant in the lubricating oil composition is at least 0.79 mg KOH/g to 2.5 mg KOH/g, and

one or more calcium-containing detergents are present in an amount to provide greater than 0.01 wt.% calcium to 0.25 wt.%, based on a total weight of the lubricating oil composition, and

wherein the amount of phosphorus (P) in weight percent provided to the lubricating oil composition by the one or more ZDDP compounds multiplied by the total base number (TBN) of the one or more dispersants derived from PIBSA in the lubricating oil composition is a multiplication factor P*TBNDisp of at least 0.051.

5. The lubricating oil composition of claim 4, wherein the P*TBNDisp multiplication factor is more than 0.06 to 0.5.

6. The lubricating oil composition of claim 4, wherein the P*TBNDisp multiplication factor is at least 0.051 and the one or more ZDDP compounds is present in a sufficient amount to provide greater than 0.065 wt.% of P based on the total weight of the lubricating oil composition.

7. The lubricating oil composition of claim 1, wherein the one or more ZDDP compounds is derived from one or more secondary alkyl alcohol(s) having an alkyl group with 3 to 8 carbon atoms.

8. The lubricating oil composition of claim 4, wherein the one or more ZDDP compounds is derived from one or more secondary alkyl alcohol(s) having an alkyl group with 3 to 8 carbon atoms.

9. The lubricating oil composition of claim 1, wherein the one or more ZDDP compounds is a mixture of all primary alcohol ZDDP compounds and all secondary alcohol ZDDP compounds.

10. The lubricating oil composition of claim 4, wherein the one or more ZDDP compounds is a mixture of all primary alcohol ZDDP compounds and all secondary alcohol ZDDP compounds.

11. The lubricating oil composition of claim 9, wherein the mixture comprises all primary alcohol ZDDP compounds contributing 15 to 500 ppmw zinc and all secondary alcohol ZDDP compounds contributing 100 to 1000 ppmw zinc to the lubricating oil composition based on the weight of the lubricating oil composition.

12. The lubricating oil composition of claim 10, wherein the mixture comprises all primary alcohol ZDDP compounds contributing 15 to 500 ppmw zinc and all secondary alcohol ZDDP compounds contributing 100 to 1000 ppmw zinc to the lubricating oil composition based on the weight of the lubricating oil composition.

13. The lubricating oil composition of claim 1, wherein the one or more dispersants comprises at least one dispersant derived from polyisobutylene succinic anhydride ("PIBSA"), and the PIBSA has an average of 1.0 and 2.0 succinic acid moieties per polyisobutylene (PIB) polymer.

14. The lubricating oil composition of claim 4, wherein the one or more dispersants comprises at least one dispersant derived from polyisobutylene succinic anhydride ("PIBSA"), and the PIBSA has an average of 1.0 and 2.0 succinic acid moieties per polyisobutylene (PIB) polymer.

15. The lubricating oil composition of claim 1, wherein the one or more dispersants derived from PIBSA is a mixture of at least one dispersant that is post-treated and at least one dispersant that is not post-treated.

16. The lubricating oil composition of claim 4, wherein the one or more dispersants derived from PIBSA is a mixture of at least one dispersant that is post-treated and at least one dispersant that is not post-treated.

17. A method of reducing engine sludge of an internal combustion engine, the method comprising adding to the engine the lubricating oil composition of claim 1 and operating said engine, wherein the lubricating oil composition provides results of an Average Engine Sludge test (ASTM D8256) of 7.01 minutes or higher.

18. A method of reducing engine sludge of an internal combustion engine, the method comprising adding to the engine the lubricating oil composition of claim 4 and operating said engine, wherein the lubricating oil composition provides results of an Average Engine Sludge test (ASTM D8256) of 7.01 minutes or higher.

19. A method of improving the fuel economy performance and/or piston cleanliness performance of an engine and/or a vehicle, comprising the step of providing the engine and/or the vehicle with a lubricant composition according to claim 1.

20. A method of improving the fuel economy performance and/or piston cleanliness performance of an engine and/or a vehicle, comprising the step of providing the engine and/or the vehicle with a lubricant composition according to claim 4.