warming, slow cooling, and soaking cycles. The MRV test measures an apparent yield stress and viscosity, which, if greater than threshold values, suggests a potential lubricant pumpability issue.

SUMMARY AND TERMS

[0004a] In a first aspect of the present disclosure, there is provided a low-temperature stable lubricating composition exhibiting pumpability comprising:

a base oil of lubricating viscosity;

0.5 to 1.0 weight percent of a polymeric additive including a blend of an esterified styrene-maleic anhydride copolymer and a poly(meth)acrylate copolymer effective to maintain a pumpable fluid, wherein the polymeric additive includes 40 weight percent to 60 weight percent of the esterified styrene-maleic anhydride copolymer based on the total weight of the esterified styrene-maleic anhydride copolymer and the poly(meth)acrylate copolymer; and wherein the lubricating composition with the polymeric additive maintains a pumpable fluid at temperature down to -40 °C. as evidenced by passing MRV performance pursuant to ASTM D4684 with a viscosity less than 60,000 cP and a yield stress less than 35.

[0004b] In another aspect of the present disclosure, there is provided a method for maintaining a pumpable viscosity of a lubricating composition, the method comprising adding to a lubricating composition 0.5 to 1 weight percent of a polymeric additive effective to maintain a pumpable fluid as evidenced by a passing MRV performance pursuant to ASTM D4684 at temperatures down to -40 °C.; wherein the polymeric additive includes a blend of an esterified styrene-maleic anhydride copolymer and a poly(meth)acrylate copolymer, wherein the polymeric additive includes 40 weight percent to 60 weight percent of the esterified styrene-maleic anhydride copolymer based on the total weight of the esterified styrene-maleic anhydride copolymer and the poly(meth)acrylate copolymer.

[0005] In one approach or example, a low-temperature stable lubricating composition exhibiting good pumpability is described herein wherein pumpability is measured pursuant to the MRV test of ASTM D4684 at about -40C. In approaches, the compositions include a base oil of lubricating viscosity and a polymeric additive including a blend of a modified styrene-maleic anhydride copolymer and a poly(meth)acrylate copolymer effective to maintain a pumpable fluid.

[0006] In other approaches, the low-temperature stable lubricating composition of the previous paragraph may also include a number of optional features in any combination. These optional features include one or more of: wherein the lubricating composition further includes one or more of a succinimide dispersant, a borated succinimide dispersant, an overbased calcium sulfonate, an overbased magnesium sulfonate, a zinc dialkyldithiophosphates, an alkylated diphenyl amine antioxidant, an antifoamant, or combinations thereof; and/or wherein the modified styrene-maleic anhydride copolymer is an esterified styrene-maleic anhydride copolymer; and/or wherein the esterified styrene-maleic anhydride copolymer is esterified with a long chain alcohol having an alkyl chain length of 10 to 24 carbons; and/or wherein the esterified styrene-maleic anhydride copolymer has a number average molecular weight of about 10,000 to about 100,000; and/or wherein the poly(meth)acrylate copolymer includes reactants selected from C1 to C24 linear or branched alkyl (meth)acrylate reactants; and/or wherein a number average molecular weight of the poly(meth)acrylate copolymer is about 20,000 or more; and/or wherein the lubricating composition includes about 1 weight percent or less of the polymeric additive blend, preferably about 0.5 to about 0.6 weight percent; and/or wherein the ratio of the modified styrene-maleic anhydride copolymer to the poly(meth)acrylate copolymer is about 1:2 to about 1:0.7; and/or wherein the polymeric additive blend includes about 40 weight percent to about 60 weight percent of the modified styrene-maleic anhydride copolymer based on the total weight of the modified styrene-maleic anhydride copolymer and the poly(meth)acrylate copolymer.

[0007] In other approaches or examples, a method for maintaining a pumpable viscosity of a lubricating composition pursuant to the MRV test of ASTM D4684 is also described herein. In approaches, the method includes adding to a lubricating composition the additive of either previous paragraph of this Summary effective to maintain a pumpable fluid as evidenced by a measured MRV performance at temperatures down to about -40 °C. In other approaches or examples, use of a polymer additive as described in this Summary is described herein for achieving a passing MRV pumpability pursuant to ASTM D4684.

[0008] The following definitions of terms are provided in order to clarify the meanings of certain terms as used herein.

[0009] 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.

[00010] 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 portion of the lubricating oil composition excluding the major amount of base oil stock mixture. The additive package may or may not include the viscosity index improver or pour point depressant.

[00011] The term "overbased" relates to metal salts, such as metal salts of sulfonates, carboxylates, salicylates, and/or phenates, wherein the amount of metal present exceeds the stoichiometric amount. Such salts may have a conversion level in excess of 100% (i.e., they may comprise more than 100% of the theoretical amount of metal needed to convert the acid to its "normal," "neutral" salt). The expression "metal ratio," often abbreviated as MR, is used to designate the ratio of total chemical equivalents of metal in the overbased salt to chemical equivalents of the metal in a neutral salt according to known chemical reactivity and stoichiometry. In a normal or neutral salt, the metal ratio is one and in an overbased salt, MR, is greater than one. They are commonly referred to as overbased, hyperbased, or superbased salts

[00017] 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.

[00018] 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.

[00019] 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.

[00020] 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.

[00021] 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.

[00022] 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.

[00023] 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.

[00024] 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).

[00025] 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).

[00026] 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.

[00027] 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-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, C1, C2, C3, C4, C5, 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, 229.51/229.31, 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.

[00028] 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.

[00029] 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.

[00030] 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.

[00031] 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.

[00032] 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,

CLAIMS

WHAT IS CLAIMED IS

1. A low-temperature stable lubricating composition exhibiting pumpability comprising:

a base oil of lubricating viscosity;

0.5 to 1.0 weight percent of a polymeric additive including a blend of an esterified styrene-maleic anhydride copolymer and a poly(meth)acrylate copolymer effective to maintain a pumpable fluid, wherein the polymeric additive includes 40 weight percent to 60 weight percent of the esterified styrene-maleic anhydride copolymer based on the total weight of the esterified styrene-maleic anhydride copolymer and the poly(meth)acrylate copolymer; and wherein the lubricating composition with the polymeric additive maintains a pumpable fluid at temperature down to -40 °C. as evidenced by passing MRV performance pursuant to ASTM D4684 with a viscosity less than 60,000 cP and a yield stress less than 35.

2. The low-temperature stable lubricating composition of claim 1, wherein the lubricating composition further includes one or more of a succinimide dispersant, a borated succinimide dispersant, an overbased calcium sulfonate, an overbased magnesium sulfonate, a zinc dialkyldithiophosphates, an alkylated diphenyl amine antioxidant, an antifoamant, or combinations thereof.

3. The low temperature stable lubricating composition of claim 1, wherein the esterified styrene-maleic anhydride copolymer is esterified with a long chain alcohol having an alkyl chain length of 10 to 22 carbons.

4. The low temperature stable lubricating composition of claim 3, wherein the esterified styrene-maleic anhydride copolymer has a number average molecular weight of 10,000 to 100,000.

5. The low-temperature stable lubricating composition of claim 1, wherein the poly(meth)acrylate copolymer includes reactants selected from C1 to C24 linear or branched alkyl (meth)acrylate reactants.

6. The low-temperature stable lubricating composition of claim 5, wherein a number average molecular weight of the poly(meth)acrylate copolymer is 20,000 or more.

7. The low-temperature stable lubricating composition of claim 1, wherein the ratio of the esterified styrene-maleic anhydride copolymer to the poly(meth)acrylate copolymer is 1:2 to 1:0.7.

8. The low temperature stable lubricating composition of claim 1, wherein the esterified styrene-maleic anhydride copolymer is esterified with a long chain alcohol having an alkyl chain length of 10 to 22 carbons and has a number average molecular weight of 10,000 to 100,000; wherein the poly(meth)acrylate copolymer includes a blend of one or more of C1 to C4 (meth)acrylate monomer units, C12 to C16 (meth)acrylate monomer units, or C16 to C20 (meth)acrylate monomer units and has a number average molecular weight 20,000 or more.

9. A method for maintaining a pumpable viscosity of a lubricating composition, the method comprising adding to a lubricating composition 0.5 to 1 weight percent of a polymeric additive effective to maintain a pumpable fluid as evidenced by a passing MRV performance pursuant to ASTM D4684 at temperatures down to -40 °C.; wherein the polymeric additive includes a blend of an esterified styrene-maleic anhydride copolymer and a poly(meth)acrylate copolymer, wherein the polymeric additive includes 40 weight percent to 60 weight percent of the esterified styrene-maleic anhydride copolymer based on the total weight of the esterified styrene-maleic anhydride copolymer and the poly(meth)acrylate copolymer.

10. The method of claim 9, wherein the esterified styrene-maleic anhydride copolymer is esterified with a long chain alcohol having an alkyl chain length of 10 to 22 carbons.

11. The method of claim 10, wherein the esterified styrene-maleic anhydride copolymer has a number average molecular weight of 10,000 to 100,000.

12. The method of claim 9, wherein the poly(meth)acrylate copolymer includes reactants selected from C1 to C24 linear or branched alkyl (meth)acrylate reactants.

13. The method of claim 12, wherein a number average molecular weight of the poly(meth)acrylate copolymer is 20,000 or more.

14. The method of claim 9, wherein the ratio of the esterified styrene-maleic anhydride copolymer to the poly(meth)acrylate copolymer is 1:2 to 1:0.7.

15. The method of claim 9, wherein the esterified styrene-maleic anhydride copolymer is esterified with a long chain alcohol having an alkyl chain length of 10 to 22 carbons and has a number average molecular weight of 10,000 to 100,000; wherein the poly(meth)acrylate copolymer includes a blend of one or more of C1 to C4 (meth)acrylate monomer units, C12 to C16 (meth)acrylate monomer units, or C16 to C20 (meth)acrylate monomer units and has a number average molecular weight 20,000 or more; and wherein the lubricating composition with the polymeric additive maintains a pumpable fluid at temperature down to -40 °C. as evidenced by a passing MRV performance pursuant to ASTM D4684 with a viscosity less than 60,000 cP and a yield stress less than 35.