500˚C or lower as measured by a differential thermal analysis and a shear stability index (SSI) of 40 or less to a lubricant oil base oil.

US 20090270294 discloses a mixture of at least two polymers having a difference of permanent shear stability index (PSSI).

EP1436369 discloses a biodegradable lubricant that is at least 60% biodegradable and has a gelation index of about 12 or less can be formulated using a trans-esterified triglyceride base oil together with a synthetic ester. A combination of an ester viscosity index improver and an olefin copolymer viscosity index improver also can be added.

US20170088789 discloses a lubricant composition containing a (meth)-acrylate-containing polymer comprising a multiplicity of arms containing at least 20 carbon atoms, said arms being attached to a multivalent organic moiety; and an ethylene/olefin copolymer having a weight average molecular weight of about 10,000 to about 250,000.

SUMMARY OF THE INVENTION

In one aspect, the present disclosure provides a lubricating engine oil composition having a HTHS viscosity at 150^{o}C in a range of about 1.3 to about 2.9 mPa·s ~~cP~~, comprising:

a) a major amount of an oil of lubricating viscosity having a kinematic viscosity at 100^{o}C in a range of 1.5 to 6.0 mm^2/s;

b) a dispersant polymethacrylate (DPMA) VII having a Mw of from 200,000 g/mol to 450,000 g/mol;

c) a non-dispersant ethylene-based olefin copolymer viscosity index improver having a Mw of from 50,000 g/mol to 150,000 g/mol and a total ethylene content of about 30 wt % to about 70 wt %.;

d) from about 200 to about 1000 ppm of magnesium from a magnesium containing detergent; and

wherein the lubricating oil composition is substantially free of molybdenum containing element.

In another aspect, the present disclosure provides a method for improving friction and reducing wear in an internal combustion engine comprising lubricating said engine with a lubricating oil composition having a HTHS viscosity at 150^{o}C in a range of about 1.3 to about 2.9 mPa·s ~~cP~~, comprising:

Base oils suitable for use herein are any of the variety corresponding to API Group II, Group III, Group IV, and Group V oils and combinations thereof, preferably the Group III to Group V oils due to their exceptional volatility, stability, viscometric and cleanliness features.

The base oil constitutes the major component of the present lubricating oil composition and is present is an amount ranging from greater than 50 to 99 wt. % (e.g., 70 to 95 wt. %, or 85 to 95 wt. %).

The base oil may be selected from any of the synthetic or natural oils typically used as crankcase lubricating oils for spark-ignited internal combustion engines. The base oil typically has a kinematic viscosity at 100°C in a range of 1.5 to 6 mm^2/s. In the case where the kinematic viscosity at 100°C of the lubricating base oil exceeds 6 mm^2/s, low temperature viscosity properties may be reduced, and sufficient fuel efficiency may not be obtained. At a kinematic viscosity of 1.5 mm^2/s or less, formation of an oil film in a lubrication place is insufficient; for this reason, lubrication is inferior, and the evaporation loss of the lubricating oil composition may be increased.

Preferably, the base oil has a viscosity index of at least 90 (e.g., at least 95, at least 105, at least 110, at least 115, or at least 120). If the viscosity index is less than 90, not only viscosity-temperature properties, heat and oxidation stability, and anti-volatilization are reduced, but also the coefficient of friction tends to be increased; and resistance against wear tends to be reduced.

In one embodiment, the lubricating oil composition is a multi-grade oil. In another embodiment, the multi-grade oil is a viscosity grade SAE 0W-XX oil, wherein XX is any one of 8, 10, 12, 16, and 20.

The lubricating oil composition has a high temperature shear (HTHS) viscosity at 150°C of 2.9 mPa·s~~cP~~ or less (e.g., 1.0 to 2.9 mPa·s~~cP~~, or 1.3 to 2.9 mPa·s~~cP~~) of 2.6 mPa·s~~cP~~ or less (e.g., 1.0 to 2.6 mPa·s~~cP~~, or 1.3 to 2.6 mPa·s~~cP~~) of 2.3 mPa·s~~cP~~ or less (e.g., 1.0 to 2.3 mPa·s~~cP~~, or 1.3 to 2.3 mPa·s~~cP~~), such as 2.0 mPa·s~~cP~~ or less (e.g., 1.0 to 2.0 mPa·s~~cP~~, or 1.3 to 2.3 mPa·s~~cP~~), or even 1.7 mPa·s~~cP~~ or less (e.g., 1.0 to 1.7 mPa·s~~cP~~, or 1.3 to 1.7 mPa·s~~cP~~).

The lubricating oil composition has a viscosity index of at least 135 (e.g., 135 to 400, or 135 to 250), at least 150 (e.g., 150 to 400, 150 to 250), at least 165 (e.g., 165 to 400, or 165 to 250), at least 190 (e.g., 190 to 400, or 190 to 250), or at least 200 (e.g., 200 to 400, or 200 to 250). If the viscosity index of the lubricating oil composition is less than 135, it may be difficult to improve fuel efficiency while maintaining the HTHS viscosity at 150°C. If the viscosity index of the lubricating oil composition exceeds 400, evaporation properties may be reduced,

and deficits due to insufficient solubility of the additive and matching properties with a seal material may be caused.

WHAT IS CLAIMED IS:

1. A lubricating oil composition having a HTHS viscosity at 150°C in a range of -1.3 to 2.9 m ~~cP~~Pa·s, comprising:
    a) an amount of an oil of lubricating viscosity having a kinematic viscosity at 100°C in a range of 1.5 to 6.0 mm^2/s in excess of 50 wt. % of the lubricating oil composition;
    b) a dispersant polymethacrylate (DPMA) VII having a Mw of from 200,000 g/mol to 450,000 g/mol;
    c) a non-dispersant ethylene-based olefin copolymer viscosity index improver having a Mw of from 50,000 g/mol to 150,000 g/mol and a total ethylene content of 30 wt % to 70 wt %.;
    d) from 200 to 1000 ppm of magnesium from a magnesium containing detergent; and
    wherein the lubricating oil composition is substantially free of molybdenum containing element.

2. The lubricating oil composition of claim 1, further comprising from 1 to 10 wt.%. of an ester base oil.

3. The lubricating oil composition of claim 1, wherein the magnesium containing detergent is a magnesium salicylate derived from a C_{20}-C_{24} isomerized normal alpha olefin.

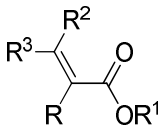
4. The lubricating oil composition of claim 1, wherein the non-dispersant ethylene-based olefin copolymer viscosity index improver has a total ethylene content of 55 to 65 wt. %.

5. The lubricating oil composition of claim 1, wherein the non-dispersant ethylene-based olefin copolymer viscosity index improver has a Mw of from 70,000 g/mol to 110,000 g/mol.

6. The lubricating oil composition of claim 1, wherein the dispersant polymethacrylate (DPMA) VII has a Mw of from 200,000 g/mol to 300,000 g/mol.

7. The lubricating oil composition of claim 1, wherein the dispersant polymethacrylate VII comprise monomer units of:

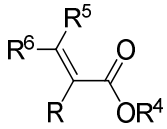
(a) 0 to 40% by weight of one or more ethylenically unsaturated ester compounds of the formula (I):



Formula I

wherein R is hydrogen or methyl, R^1 is a saturated or unsaturated linear or branched alkyl radical having 1 to 5 carbon atoms or a saturated or unsaturated cycloalkyl group having 3 to 5 carbon atoms, R^2 and R^3 are each independently hydrogen or a group of the formula - COOR' wherein R' is hydrogen or a saturated or unsaturated linear or branched alkyl group having 1 to 5 carbon atoms;

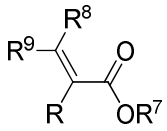
(b) 10 to 98% by weight, preferably 20 to 95% by weight, of one or more ethylenically unsaturated ester compounds of the formula (II)



Formula II

wherein R is hydrogen or methyl, R^4 is a saturated or unsaturated linear or branched alkyl radical having 6 to 15 carbon atoms or a saturated or unsaturated cycloalkyl group having 6 to 15 carbon atoms, R^5 and R^6 are each independently hydrogen or a group of the formula -COOR" in which R" is hydrogen or a saturated or unsaturated linear or branched alkyl group having 6 to 15 carbon atoms;

(c) 0 to 30% by weight, preferably 5 to 20% by weight, of one or more ethylenically unsaturated ester compounds of the formula (III):



Formula III

wherein R is hydrogen or methyl, R^7 is a saturated or unsaturated linear or branched alkyl radical having 16 to 40 preferably 16 to 30, carbon atoms or a cycloalkyl group having 16 to 40, preferably 16 to 30, carbon atoms, R^8 and R^9

are each independently hydrogen or a group of the formula -COOR'" in which R'" is hydrogen or a saturated or unsaturated linear or branched alkyl group having 16 to 40, preferably 16 to 30, carbon atoms;

(d) 0 to 30% by weight of vinyl monomers;

(e) 2 to 10% by weight of at least one N-dispersant monomer.

8. The lubricating oil composition of claim 1, wherein the non-dispersant ethylene-based olefin copolymer is an ethylene propylene copolymer.

9. The lubricating oil composition of claim 1, wherein the magnesium from the magnesium containing detergent is from 200 to 850 ppm.

10. A method of improving friction and reducing wear in an internal combustion engine comprising lubricating said engine with a lubricating oil composition having a HTHS viscosity at 150°C in a range of -1.3 to -2.9 mPa·s ~~cP~~, comprising:

a) an amount of an oil of lubricating viscosity having a kinematic viscosity at 100°C in a range of 1.5 to 6.0 mm^2/s in excess of 50 wt. % of the lubricating oil composition;

b) a dispersant polymethacrylate (DPMA) VII having a Mw of from 200,000 g/mol to 450,000 g/mol;

c) a non-dispersant ethylene-based olefin copolymer viscosity index improver having a Mw of from 50,000 g/mol to 150,000 g/mol and a total ethylene content of 30 wt % to 70 wt %.;

d) from 200 to 1000 ppm of magnesium from a magnesium containing detergent; and

wherein the lubricating oil composition is substantially free of molybdenum containing element.

11. The method of claim 10, wherein the lubricating oil composition further comprises from 1 to 10 wt.%. of an ester base oil.

12. The method of claim 10, wherein the magnesium containing detergent is a magnesium salicylate derived from a C_{20}-C_{24} isomerized normal alpha olefin.

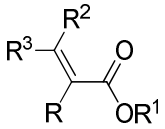
13. The method of claim 10, wherein the non-dispersant ethylene-based olefin copolymer viscosity index improver has a total ethylene content of 55 to 65 wt. %.

14. The method of claim 10, wherein the non-dispersant ethylene-based olefin copolymer viscosity index improver has a Mw of from 70,000 g/mol to 110,000 g/mol.

15. The method of claim 10, wherein the dispersant polymethacrylate (DPMA) VII has a Mw of from 200,000 g/mol to 300,000 g/mol.

16. The method of claim 10, wherein the wherein the dispersant polymethacrylate VII comprises monomer units of:

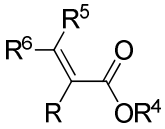
(a) 0 to 40% by weight of one or more ethylenically unsaturated ester compounds of the formula (I):



Formula I

wherein R is hydrogen or methyl, R^1 is a saturated or unsaturated linear or branched alkyl radical having 1 to 5 carbon atoms or a saturated or unsaturated cycloalkyl group having 3 to 5 carbon atoms, R^2 and R^3 are each independently hydrogen or a group of the formula - COOR' wherein R' is hydrogen or a saturated or unsaturated linear or branched alkyl group having 1 to 5 carbon atoms;

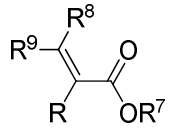
(b) 10 to 98% by weight, preferably 20 to 95% by weight, of one or more ethylenically unsaturated ester compounds of the formula (II)



Formula II

wherein R is hydrogen or methyl, R^4 is a saturated or unsaturated linear or branched alkyl radical having 6 to 15 carbon atoms or a saturated or unsaturated cycloalkyl group having 6 to 15 carbon atoms, R^5 and R^6 are each independently hydrogen or a group of the formula -COOR" in which R" is hydrogen or a saturated or unsaturated linear or branched alkyl group having 6 to 15 carbon atoms;

(c) 0 to 30% by weight, preferably 5 to 20% by weight, of one or more ethylenically unsaturated ester compounds of the formula (III):



Formula III

wherein R is hydrogen or methyl, R^7 is a saturated or unsaturated linear or branched alkyl radical having 16 to 40 preferably 16 to 30, carbon atoms or a cycloalkyl group having 16 to 40, preferably 16 to 30, carbon atoms, R^8 and R^9 are each independently hydrogen or a group of the formula -COOR'" in which R'" is hydrogen or a saturated or unsaturated linear or branched alkyl group having 16 to 40, preferably 16 to 30, carbon atoms;

(d) 0 to 30% by weight of vinyl monomers;

(e) 2 to 10% by weight of at least one N-dispersant monomer.

17. The method of claim 10 wherein the non-dispersant ethylene-based olefin copolymer is an ethylene propylene copolymer.

18. The method of claim 10, wherein the magnesium from the magnesium containing detergent is from 200 to 850 ppm.