[0005] For instance, molybdenum-based compounds are widely used as a friction modifier and, in some instances, aide in achieving passing performance in motored friction tests, such as for example, the JASO M 365 motored friction test of the JASO GLV-1 specifications. However, when formulating lower viscosity grade lubricants, such as 0W-8, 0W-12, 0W-16, or 0W-20 lubricants, with levels of molybdenum to achieve passing motored friction performance, it becomes difficult to also achieve passing performance on the Sequence IVB Engine test of ASTM D8350 that evaluates the effect of the lubricant on tappet wear for engines with direct-acting overhead cam valve trains.

SUMMARY

[0006] The present disclosure relates to lubricating compositions for an engine oil composition providing improved low temperature valve train wear pursuant to the Sequence IVB engine test of ASTM D8350. In one aspect, the disclosure provides an engine lubricating oil composition providing improved low temperature valve train wear pursuant to the Sequence IVB engine test of ASTM D8350, the engine oil lubricating composition comprising: one or more base oils of lubricating viscosity; 300 to 1000 ppm molybdenum from an oil-soluble molybdenum compound; one or more metal-containing detergents providing greater than 5 TBN to the lubricating oil composition, wherein the TBN is measured using ASTM D4739; wherein at least one of the one or more metal-containing detergents comprises an overbased magnesium detergent providing greater than 2 TBN to the lubricating oil composition, wherein the TBN is measured using ASTM D4739; less than 0.2 weight percent of a polymeric pour point depressant; wherein the engine oil composition has a viscosity grade according to SAE J 300 of 0W-8, 0W-12, 0W-16, or 0W-20; and wherein a weight ratio of magnesium-to-molybdenum is 0.8:1 or less. In one example, the engine oil lubricating composition includes one or more base oils of lubricating viscosity, about 300 to about 1000 ppm molybdenum from an oil-soluble molybdenum compound, one or more metal-containing detergents providing greater than about 5 TBN to the lubricating oil composition (wherein the TBN is measured using ASTM D4739), and wherein at least one of the one or more metal-containing detergents comprises an overbased magnesium detergent providing greater than about 2 TBN to the lubricating oil composition (wherein the TBN is measured using ASTM D4739). In an example, the engine oil lubricating composition may also include less than about 0.2 weight percent of a polymeric pour point depressant and wherein the engine oil composition has a viscosity grade according to SAE J 300 of 0W-8, 0W-12, 0W-16, or 0W-20.

[0007] In other examples or approaches, the lubricating composition of the previous paragraph may include optional features or examples in any combination. These optional features or example may include one or more of the following: wherein the one or more overbased magnesium-containing detergent includes a magnesium sulfonate; and/or wherein the lubricating oil composition further includes a calcium-containing detergent; and/or wherein the one or more overbased magnesium-containing detergent has a total base number (TBN) of at least about 250 mg KOH/g; and/or wherein the polymeric pour point depressant is a poly(meth)acrylate-based pour point depressant; and/or wherein the polymeric pour point depressant is a poly(meth)acrylate copolymer having monomer units including (i) one or more monomer units selected from C1 to C16 (meth)acrylates and (2) vinyl pyrrolidone

monomer units; and/or wherein the engine lubricating oil composition is substantially free of poly(meth)acrylate-based dispersant pour point depressants; and/or wherein the lubricating oil composition lubricates a hybrid gasoline-electric engine; and/or wherein the hybrid gasoline electric engine includes a 2.0 liter or smaller gasoline engine; and/or wherein the lubricating oil composition exhibits an average intake lifter volume loss of 2.7 mm^3 or less and a maximum end-of-test iron content of 400 ppm or less when measured pursuant to the sequence IVB engine test of ASTM D8350.

[0008] In other approaches or examples, a method of lubricating a hybrid gasoline-electric engine to achieve improved low temperature valve train wear pursuant to the Sequence IVB engine test of ASTM D8350 is described herein. In one aspect, the disclosure provides a method of lubricating a hybrid gasoline-electric engine to achieve improved low temperature valve train wear pursuant to the Sequence IVB engine test of ASTM D8350, the method comprising: lubricating a hybrid electric-gasoline engine with a lubricating oil composition having a viscosity grade according to SAE J 300 of 0W-8, 0W-12, 0W-16, or 0W-20; and the lubricating oil composition including one or more base oils of lubricating viscosity; 300 to 1000 ppm molybdenum from an oil-soluble molybdenum compound; one or more metal-containing detergent providing greater than 5 TBN to the lubricating oil composition, wherein TBN is measured using ASTM D4739; wherein the at least one of the one or more metal-containing detergent comprises an overbased magnesium detergent providing greater than 2 TBN to the lubricating oil composition, wherein the TBN is measured using ASTM D4739; and less than 0.2 weight percent of a polymeric pour point depressant; and wherein a weight ratio of magnesium-to-molybdenum in the lubricating oil composition is 0.8:1 or less. In one example, the method includes lubricating a hybrid electric-gasoline engine with a lubricating oil composition having a viscosity grade according to SAE J 300 of 0W-8, 0W-12, 0W-16, or 0W-20; and wherein the lubricating oil composition includes one or more base oils of lubricating viscosity; about 300 to about 1000 ppm molybdenum from an oil-soluble molybdenum compound; one or more metal-containing detergent providing greater than about 5 TBN to the lubricating oil composition, wherein TBN is measured using ASTM D4739; wherein the at least one of the one or more metal-containing detergent comprises an overbased magnesium detergent providing greater than about 2 TBN to the lubricating oil composition, wherein the TBN is measured using ASTM D4739; and less than about 0.2 weight percent of a polymeric pour point depressant.

[0009] In other approaches or examples, the method of the previous paragraph may include optional features, examples, or method steps in any combination. These optional features examples, or steps may include one or more of the following: the one or more overbased magnesium-containing detergents includes a magnesium sulfonate; and/or wherein the lubricating oil composition further includes a calcium-containing detergent; and/or wherein the one or more overbased magnesium-containing detergents has a total base number (TBN) of at least about 250 mg KOH/g; and/or wherein the polymeric pour point depressant is a poly(meth)acrylate-based pour point depressant; and/or wherein the polymeric pour point depressant is a poly(meth)acrylate copolymer having monomer units including (i) one or more monomer units selected from C1 to C16 (meth)acrylates and (ii) vinyl pyrrolidone monomer units; and/or wherein the lubricating oil composition is substantially free of the poly(meth)acrylate-based pour point depressants; and/or wherein the hybrid gasoline-electric engine includes a 2.0 liter or smaller gasoline engine; and/or wherein the lubricating oil

composition exhibits an average intake lifter volume loss of 2.7 mm^3 or less and a maximum end-of-test iron content of 400 ppm or less when measured pursuant to the sequence IVB engine test of ASTM D8350; and/or wherein about 40 percent to about 100 percent of the detergent TBN is provided by an overbased magnesium sulfonate.

[0010] In yet other examples, the present disclosure provides for the use of any example of the lubricant compositions described in this Summary for achieving an average intake lifter volume loss of 2.7 mm^3 or less and a maximum end-of-test iron content of 400 ppm or less when measured pursuant to the sequence IVB engine test of ASTM D8350 and when using a viscosity grade according to SAE J 300 of 0W-8, 0W-12, 0W-16, or 0W-20

DETAILED DESCRIPTION

[0011] The present disclosure relates to lubricating compositions and methods of lubricating an internal combustion engine effective to maintain passing motored friction performance pursuant to JASO M365 and, at the same time, achieve improved low temperature valve train wear of the Sequence IVB engine test of ASTM D8350. As noted in the Background, low viscosity lubricants, such as 0W-8, 0W-12, 0W-16, or 0W-20 grade lubricants, may be preferred for targeting improved fuel economy, but such low viscosity grade lubricants often require high amounts of molybdenum to achieve the desired motored friction performance. Unfortunately, such high levels of molybdenum cause issues with low viscosity lubricants also passing the valve train wear criteria of the Sequence IVB testing of ASTM D8350.

[0012] Surprisingly, lubricating compositions herein achieve passing performance in both performance tests with a boost in overbased magnesium detergent content relative to other fluid and detergent components. As detergents, as well as the soap content from detergents, is largely provided for acid neutralization, detergency, dispersancy, corrosion inhibition, and/or anti-wear, it was unexpected that selection of certain amounts and relationships of detergent metal contribution in the fluids combined with a high molybdenum content would shift a lubricant with a failing Sequence IVB performance into a lubricant with a passing Sequence IVB performance that also achieves desired motor friction performance as well. As used herein, acceptable Sequence IVB performance is an average intake lifter volume loss of 2.7 mm^3 or less and a maximum end of test iron content of 400 ppm or less. Any embodiment of the lubricants herein is particularly suited for lubricating a hybrid gasoline-

CLAIMS

What is claimed is:

1. An engine lubricating oil composition providing improved low temperature valve train wear pursuant to the Sequence IVB engine test of ASTM D8350, the engine oil lubricating composition comprising:

one or more base oils of lubricating viscosity;

300 to 1000 ppm molybdenum from an oil-soluble molybdenum compound;

one or more metal-containing detergents providing greater than 5 TBN to the lubricating oil composition, wherein the TBN is measured using ASTM D4739;

wherein at least one of the one or more metal-containing detergents comprises an overbased magnesium detergent providing greater than 2 TBN to the lubricating oil composition, wherein the TBN is measured using ASTM D4739;

less than 0.2 weight percent of a polymeric pour point depressant;

wherein the engine oil composition has a viscosity grade according to SAE J 300 of 0W-8, 0W-12, 0W-16, or 0W-20; and

wherein a weight ratio of magnesium-to-molybdenum is 0.8:1 or less.

2. The engine lubricating oil composition of claim 1, wherein the one or more overbased magnesium-containing detergent includes a magnesium sulfonate.

3. The engine lubricating oil composition of claim 1, wherein the lubricating oil composition further includes a calcium-containing detergent.

4. The engine lubricating oil composition of claim 1, wherein the one or more overbased magnesium-containing detergent has a total base number (TBN) of at least 250 mg KOH/g.

5. The engine lubricating oil composition of claim 1, wherein the polymeric pour point depressant is a poly(meth)acrylate-based pour point depressant.

6. The engine lubricating oil composition of claim 5, wherein the polymeric pour point depressant is a poly(meth)acrylate copolymer having monomer units including (i) one

or more monomer units selected from C1 to C16 (meth)acrylates and (2) vinyl pyrrolidone monomer units.

7. The engine lubricating oil composition of claim 5, wherein the engine lubricating oil composition is substantially free of poly(meth)acrylate-based dispersant pour point depressants.

8. The engine lubricating oil composition of claim 1, wherein the lubricating oil composition lubricates a hybrid gasoline-electric engine.

9. The engine lubricating oil composition of claim 8, wherein the hybrid gasoline electric engine includes a 2.0 liter or smaller gasoline engine.

10. The engine lubricating oil composition of claim 1, wherein the lubricating oil composition exhibits an average intake lifter volume loss of 2.7 mm^3 or less and a maximum end-of-test iron content of 400 ppm or less when measured pursuant to the sequence IVB engine test of ASTM D8350.

11. A method of lubricating a hybrid gasoline-electric engine to achieve improved low temperature valve train wear pursuant to the Sequence IVB engine test of ASTM D8350, the method comprising:

lubricating a hybrid electric-gasoline engine with a lubricating oil composition having a viscosity grade according to SAE J 300 of 0W-8, 0W-12, 0W-16, or 0W-20; and

the lubricating oil composition including one or more base oils of lubricating viscosity; 300 to 1000 ppm molybdenum from an oil-soluble molybdenum compound; one or more metal-containing detergent providing greater than 5 TBN to the lubricating oil composition, wherein TBN is measured using ASTM D4739; wherein the at least one of the one or more metal-containing detergent comprises an overbased magnesium detergent providing greater than 2 TBN to the lubricating oil composition, wherein the TBN is measured using ASTM D4739; and less than 0.2 weight percent of a polymeric pour point depressant; and wherein a weight ratio of magnesium-to-molybdenum in the lubricating oil composition is 0.8:1 or less.

12. The method of claim 11, wherein the one or more overbased magnesium-containing detergents includes a magnesium sulfonate.

13. The method of claim 11, wherein the lubricating oil composition further includes a calcium-containing detergent.

14. The method of claim 11, wherein the one or more overbased magnesium-containing detergents has a total base number (TBN) of at least 250 mg KOH/g.

15. The method of claim 11, wherein the polymeric pour point depressant is a poly(meth)acrylate-based pour point depressant.

16. The method of claim 15, wherein the polymeric pour point depressant is a poly(meth)acrylate copolymer having monomer units including (i) one or more monomer units selected from C1 to C16 (meth)acrylates and (ii) vinyl pyrrolidone monomer units.

17. The method of claim 15, wherein the lubricating oil composition is substantially free of the poly(meth)acrylate-based pour point depressants.

18. The method of claim 11, wherein the hybrid gasoline-electric engine includes a 2.0 liter or smaller gasoline engine.

19. The method of claim 11, wherein the lubricating oil composition exhibits an average intake lifter volume loss of 2.7 mm^3 or less and a maximum end-of-test iron content of 400 ppm or less when measured pursuant to the sequence IVB engine test of ASTM D8350.

20. The method of claim 11, wherein 40 percent to 100 percent of the detergent TBN is provided by an overbased magnesium sulfonate.