LUBRICATING COMPOSITION FOR DURABILITY AND ENHANCED FUEL ECONOMY

TECHNICAL FIELD

[0001] The present disclosure relates to lubricating compositions and, in particular, lubricating compositions exhibiting improved piston cleanliness with improved fuel economy

BACKGROUND

[0002] Automotive manufacturers continue to the push for improved efficiency, fluid longevity, and fuel economy, and as such, demands on engines, lubricants, and their components continue to increase. Today's engines are often smaller, lighter and more efficient with technologies designed to improve fuel economy, performance, and power. These requirements also mean engine oil performance must evolve to meet the higher demands of such modern engines and their corresponding performance criteria tied to their unique use and applications. With such exacting demands for engine oils, lubricant manufacturers often tailor lubricants and their additives to meet certain performance requirements for industry and/or manufacturer applications.

[0003] Typically, industry standards and/or automotive manufacturers require certain performance such that a lubricant designed for one use or application may not satisfy all the requirements for a different use or application. For example, there are often tradeoffs in engine oil performance between fuel economy and durability (i.e., piston cleanliness). Fuel economy can be evaluated, for example, through the JASO M 366 fuel economy test, and durability can be evaluated through the VW TDi3 piston cleanliness test of CEC L-117-20. Formulations that are good for fuel economy tend to be detrimental to piston cleanliness and vice-versa. Such opposing criteria presents a challenge for the lubricant manufacturer.

SUMMARY

[0004] In one aspect, the present disclosure refers to an engine lubricating oil composition for lubricating a diesel internal combustion engine, the engine lubricating oil composition comprising: one or more base oils of lubricating viscosity, wherein the one or more base oils have a combined base oil viscosity at 100° C. of less than or equal to 5.4 cSt; a detergent system providing a minimum total base number (TBN), measured pursuant to ASTM D4739, to the engine lubricating oil composition of at least 4 to 7 mg KOH/g, and wherein the detergent system includes only a magnesium-containing detergent additive; wherein the

engine lubricating oil composition has (i) a NOACK volatility of 13% or less measured pursuant to CEC L-40-90 and/or ASTM D5800; (ii) a total base number (TBN) of the engine lubricating oil composition of 7 to 9 mg KOH/g measured pursuant to ASTM D2896; (iii) a calculated sulfated ash content (SASH) of 0.8 weight percent or less measured pursuant to ASTM D874; and (iv) a CCS viscosity at -35° C. of 6200 mPas or less measured pursuant to ASTM D5292. The present disclosure relates to engine lubricating oil compositions including one or more base oils of lubricating viscosity, wherein the one or more base oils have a combined base oil viscosity at 100°C of less than or equal to about 5.4 cSt; a detergent system providing a minimum total base number (TBN), measured pursuant to ASTM D4739, to the engine lubricating oil composition of at least about 4 mg KOH/g; and wherein the engine lubricating oil composition has one or more of (i) a NOACK volatility of about 13% or less measured pursuant to CEC L-40-93 and/or ASTM D5800; (ii) a total base number (TBN) of the engine

lubricating oil composition of about 10 or less mg KOH/g measured pursuant to ASTM D2896; (iii) a calculated sulfated ash content (SASH) of about 0.8 weight percent or less measured pursuant to ASTM D874; (iv) a CCS viscosity at -35°C of about 6200 mPas or less measured pursuant to ASTM D5292; or (v) combinations thereof. Such examples of the engine lubricating oil compositions herein meet or exceed lubricant performance set forth in the CEC L-117-20 (VW TDi3) piston cleanliness test, and preferably exhibit a piston cleanliness rating of at least about 53 merits, at least about 54 merits, at least about 55 merits, at least about 56 merits, at least about 57 merits, at least about 58 merits, or at least about 59 merits. Such examples of the engine lubricating oil compositions herein also have a positive fuel economy increase as measured pursuant to JASO M 366, and preferably exhibit a fuel economy improvement as measured pursuant to JASO M 366 of at least about 0.5%, at least about 0.6%, at least about 0.7%, or at least about 0.8%.

[0005] In other approaches or examples, the engine lubricating oil composition of the previous paragraph may include optional features or examples in any combination. These optional features or examples may include one or more of: wherein the detergent system is substantially free of phenate detergent additives; and/or wherein the detergent system comprises, consists of, or consists essentially of sulfonate detergent additives, and preferably the detergent system is only sulfonate detergent additives; and/or wherein the detergent system provides calcium, magnesium, or combinations thereof to the engine lubricating oil composition, and preferably, the detergent system includes only a magnesium-containing detergent additive; and/or wherein the detergent system provides about 800 to about 1800 ppm of magnesium to the engine lubricating oil composition, about 1000 to about 1500 ppm of magnesium, or about 1200 to about 1400 ppm of magnesium; and/or wherein the detergent system includes one or more overbased detergent additives having a total base number (TBN) as measured pursuant to ASTM D2896 of at least about 250 mg KOH/g, preferably at least about 300 mg KOH/g, more preferably at least about 350 mg KOH/g, or most preferably at least bout 400 mg KOH/g; and/or wherein the engine lubricating oil composition has a TBN of about 8 or less measured pursuant to ASTM D2896; and/or wherein the TBN of the detergent system is about 4 to about 10 mg KOH/g as measured pursuant to ASTM D4739; and/or further comprising an oil-soluble molybdenum containing additive, preferably a molybdenum dialkyl dithiocarbamate compound; and/or further comprising molybdenum but no more than about 800 ppm of molybdenum, no more than about 700 ppm molybdenum, no more than about 600 ppm of molybdenum, no more than

dithiophosphate compounds; and/or wherein the one or more metal dihydrocarbyl dithiophosphate compounds provide up to about 1000 ppm phosphorus to the lubricating oil composition, up to about 900 ppm phosphorus, or up to about 800 ppm phosphorus to the lubricating oil composition; and/or wherein the one or more metal dihydrocarbyl dithiophosphate compounds provide up to about 1000 ppm zinc to the lubricating oil composition, up to about 900 ppm zinc, or up to about 850 ppm phosphorus to the lubricating oil composition; and/or further comprising one or more sulfur-containing additives, and wherein the one or more sulfur-containing additives provide up to about 2500 ppm sulfur to the lubricating oil composition, up to about 2200 ppm sulfur, or up to about 2100 ppm sulfur to the lubricating oil composition.

[0006] In another aspect, the present disclosure refers to a method of improving the fuel economy and the piston cleanliness of a passenger car diesel engine using a lubricating oil composition, the method comprising: lubricating an engine crankcase of a passenger car diesel engine with a lubricating oil composition; wherein the lubricating oil composition is as disclosed herein; and wherein the lubricating oil composition meets or exceeds lubricant performance set forth in the CEC L-117-20 (VW TDi3) piston cleanliness test with a piston cleanliness rating of at least 53 merits and the lubricating oil composition has a positive fuel economy increase as measured pursuant to JASO M 366 with a fuel economy improvement of at least 0.5%. In yet other approaches or examples, a method of improving the fuel economy and the piston cleanliness of a passenger car engine using a lubricating oil composition is described herein. The method includes lubricating an engine crankcase of a passenger car engine with a lubricating oil composition; wherein the lubricating oil composition is set forth in any example of this Summary; and wherein the lubricating oil composition meets or exceeds lubricant performance set forth in the CEC L-117-20 (VW TDi3) piston cleanliness test and the lubricating oil composition has a positive fuel economy increase as measured pursuant to JASO M 366. In some examples, the method results in a piston cleanliness rating pursuant to CEC L-117-20 (VW TDi3) of at least about 53 merits, at least about 54 merits, at least about 55 merits, at least about 56 merits, at least about 57 merits, at least about 58 merits, or at least about 59 merits. In other examples, the methods result in a fuel economy improvement as measured pursuant to JASO M 366 of at least about 0.5%, at least about 0.6%, at least about 0.7%, or at least about 0.8%. In further examples or

approaches of the method, any example of the engine oil lubricating composition as described in this Summary may be used in the methods herein.

[0007] In another aspect, the present disclosure refers to a method of lubricating a crankcase of a passenger car diesel engine using a lubricating oil composition, the method comprising: lubricating an engine crankcase of a passenger car diesel engine with a lubricating oil composition; wherein the lubricating oil composition is as disclosed herein; and wherein the passenger car engine lubricated with the lubricating oil composition meets or exceeds lubricant performance set forth in the CEC L-117-20 (VW TDi3) piston cleanliness test with a piston cleanliness rating of at least 53 merits and has a positive fuel economy increase as measured pursuant to JASO M 366 with a fuel economy improvement of at least 0.5%. In yet further examples or approaches, methods of lubricating a crankcase of a passenger car engine using a lubricating oil composition is described herein. The methods may include lubricating an engine crankcase of a passenger car engine with a lubricating oil composition; wherein the lubricating oil composition is set forth in any example of this Summary; and wherein the passenger car engine lubricated with the lubricating oil composition meets or exceeds lubricant performance set forth in the CEC L-117-20 (VW TDi3) piston cleanliness test and has a positive fuel economy increase as measured pursuant to JASO M 366.

[0008] In yet additional approaches or examples, any of the methods herein may include optional features, steps, or examples in any combination. These optional features, step, or examples may include one or more of the following: wherein the lubricating oil composition has a piston cleanliness rating pursuant to CEC L-117-20 (VW TDi3) of at least about 53 merits, at least about 54 merits, at least about 55 merits, at least about 56 merits, at least about 57 merits, at least about 58 merits, or at least about 59 merits; and/or wherein the lubricating oil composition has a fuel economy improvement as measured pursuant to JASO M 366 of at least about 0.5%, at least about 0.6%, at least about 0.7%, or at least about 0.8%.

[0009] In yet further approaches or examples, the use of any example of the engine oil lubricating composition of this Summary is described for achieving a piston cleanliness rating pursuant to CEC L-117-20 (VW TDi3) of at least about 53 merits, at least about 54 merits, at least about 55 merits, at least about 56 merits, at least about 57 merits, at least about 58 merits, or at least about 59 merits and/or for achieving a fuel economy improvement as measured pursuant to JASO M 366 of at least about 0.5%, at least about 0.6%, at least about 0.7%, or at least about 0.8%.

DETAILED DESCRIPTION

[0010] The present disclosure relates to engine lubricating oil compositions and methods of lubricating a diesel internal combustion engine effective to achieve robust performance in both durability (i.e., piston cleanliness) and improved fuel economy. In one aspect, the engine lubricating oil compositions herein have a composition effective to achieve passing piston cleanliness pursuant to CEC L-117-20 (i.e., the VW TDi3 test) and to achieve a positive fuel economy increase as measured pursuant to JASO M 366, and preferably a fuel economy improvement as measured pursuant to JASO M 366 of at least about 0.5 percent. The engine lubricating oil compositions herein may have a viscosity grade of 0W-8, 0W-12, 0W16, and/or 0W-20. The compositions herein may be used in diesel engines.

[0011] In one approach or embodiment, the robust engine lubricating oil compositions described herein have select compositions to achieve both diesel durability and improved fuel economy. In one aspect, the lubricating oil compositions herein include one or more base oils of lubricating viscosity, and in particular, one or more base oils having a combined base oil viscosity of less than or equal to about 5.4 cSt at 100°C. In another aspect, the lubricating oil compositions herein also include a detergent system providing a minimum total base

CLAIMS

What is claimed is:

1. An engine lubricating oil composition for lubricating a diesel internal combustion engine, the engine lubricating oil composition comprising:

one or more base oils of lubricating viscosity, wherein the one or more base oils have a combined base oil viscosity at 100° C. of less than or equal to 5.4 cSt;

a detergent system providing a minimum total base number (TBN), measured pursuant to ASTM D4739, to the engine lubricating oil composition of at least 4 to 7 mg KOH/g, and wherein the detergent system includes only a magnesium-containing detergent additive;

wherein the engine lubricating oil composition has (i) a NOACK volatility of 13% or less measured pursuant to CEC L-40-90 and/or ASTM D5800; (ii) a total base number (TBN) of the engine lubricating oil composition of 7 to 9 mg KOH/g measured pursuant to ASTM D2896; (iii) a calculated sulfated ash content (SASH) of 0.8 weight percent or less measured pursuant to ASTM D874; and (iv) a CCS viscosity at -35° C. of 6200 mPas or less measured pursuant to ASTM D5292.

2. The engine lubricating oil composition of claim 1, wherein the engine lubricating oil composition meets or exceeds lubricant performance set forth in the CEC L-117-20 (VW TDi3) piston cleanliness test with a piston cleanliness rating of at least 53 merits.

3. The engine lubricating oil composition of claim 2, wherein the engine lubricating oil composition has a positive fuel economy increase as measured pursuant to JASO M 366 of at least 0.5%.

4. The engine lubricating oil composition of claim 1, wherein the detergent system is substantially free of phenate detergent additives and wherein the detergent system consists essentially of sulfonate detergent additives.

5. The engine lubricating oil composition of claim 1, wherein the detergent system provides 800 to 1800 ppm of magnesium to the engine lubricating oil composition.

6. The engine lubricating oil composition of claim 1, wherein the detergent system includes one or more overbased detergent additives having a total base number (TBN) as measured pursuant to ASTM D2896 of at least 250 mg KOH/g.

7. The engine lubricating oil composition of claim 1, wherein the engine lubricating oil composition has a TBN of 8 or less measured pursuant to ASTM D2896.

8. The engine lubricating oil composition of claim 1, further comprising an oil-soluble molybdenum containing additive providing no more than 800 ppm of molybdenum to the engine lubricating oil composition.

9. The engine lubricating oil composition of claim 1, further comprising 2 to 10 weight percent of one or more polymeric viscosity index improver additives.

10. The engine lubricating oil composition of claim 9, wherein the engine lubricating oil composition has a viscosity index of 130 to 300.

11. The engine lubricating oil composition of claim 10, wherein the one or more polymeric viscosity index improver additive is one of (i) an olefin copolymer, (ii) a dispersant or a non-dispersant poly(meth)acrylate copolymer viscosity modifier having a weight average molecular weight of 500,000 or less, or (iii) combinations thereof.

12. The engine lubricating oil composition of claim 11, wherein the one or more polymeric viscosity index improver additive is the dispersant or the non-dispersant poly(meth)acrylate copolymer and has a weight average molecular weight of 200,000 to 500,000 with a polydispersity index of 1.5 to 2.5 and includes first (meth)acrylate monomer units with a hydrocarbyl group in a monomer ester moiety of up to 700 and second (meth)acrylate monomer units with a hydrocarbyl group in a monomer ester moiety of up to 10000.

13. The engine lubricating oil composition of claim 1, wherein the engine lubricating oil composition has a viscosity grade of 0W-X, wherein X is 8, 12, 16, 20, or 30.

14. The engine lubricating oil composition of claim 13, wherein the base oil viscosity is 5.2 cSt or less.

15. The engine lubricating oil composition of claim 1, wherein the engine lubricating oil composition is substantially free of boron, substantially free of calcium, or combinations thereof.

16. The engine lubricating oil composition of claim 1, further including one or more metal dihydrocarbyl dithiophosphate compounds, and wherein the one or more metal dihydrocarbyl dithiophosphate compounds provide up to 1000 ppm phosphorus to the lubricating oil composition.

17. The engine lubricating oil composition of claim 1, further comprising one or more sulfur-containing additives, and wherein the one or more sulfur-containing additives provide up to 2500 ppm sulfur to the lubricating oil composition.

18. A method of improving the fuel economy and the piston cleanliness of a passenger car diesel engine using a lubricating oil composition, the method comprising:

lubricating an engine crankcase of a passenger car diesel engine with a lubricating oil composition;

wherein the lubricating oil composition is set forth in claim 1; and

wherein the lubricating oil composition meets or exceeds lubricant performance set forth in the CEC L-117-20 (VW TDi3) piston cleanliness test with a piston cleanliness rating of at least 53 merits and the lubricating oil composition has a positive fuel economy increase as measured pursuant to JASO M 366 with a fuel economy improvement of at least 0.5%.

19. A method of lubricating a crankcase of a passenger car diesel engine using a lubricating oil composition, the method comprising:

lubricating an engine crankcase of a passenger car diesel engine with a lubricating oil composition;

wherein the lubricating oil composition is set forth in claim 1; and

wherein the passenger car engine lubricated with the lubricating oil composition meets or exceeds lubricant performance set forth in the CEC L-117-20 (VW TDi3) piston cleanliness test with a piston cleanliness rating of at least 53 merits and has a positive fuel economy increase as measured pursuant to JASO M 366 with a fuel economy improvement of at least 0.5%.