adverse effects on such after-treatment devices and lubricants are commonly formulated to minimize the sulfated ash, phosphorus, and sulfur therein.

[0005] Sulfated ash is a measurement that indicates the total weight percent of ash in a lubricating oil composition. The sulfated ash measurement for a lubricating oil composition is related to the total metal content therein and may be conveniently measured according to ASTM D-874 and/or other common evaluation methods known in the art and as described herein. In many circumstances, however, varying one component within a lubricant composition to improve certain performance characteristics tends to negatively impact one or more other performance characteristics. For instance, the major sources of ash in a lubricating oil composition are generally metal detergent additives and/or anti-wear additives. However, it has been discovered that reducing the amount of detergent or antiwear components to decrease sulfated ash content tends to negatively impact other performance characteristics, and in particular, reduced detergent and/or antiwear tends to increase deposits in the high temperature performance testing of TEOST-33C, for example.

SUMMARY

[0006] In one approach or example, a lubricating composition for reducing high temperature deposits is provided. In one example, the lubricating composition includes one or more base oil(s) of lubricating viscosity; a detergent system providing an amount of metal to the lubricating composition, where the metal is at least one of sodium, calcium, magnesium, or combinations thereof; an antiwear system including one or more metal dialkyl dithiophosphates derived from one of primary alcohols, secondary alcohols, or combinations thereof and providing an amount of phosphorus to the lubricating composition; wherein a total base number (TBN) of the lubricating composition is from about 0.5 to about 20; and wherein the amount of phosphorus from the antiwear system relative to the TBN of the lubricating composition is about 150 or less.

[0007] In other approaches, the lubricating composition of the previous paragraph may include optional features or examples. These optional features or examples may include one or more of the following in any combination: wherein the amount of phosphorus from the antiwear system relative to the TBN is about 120 or less; and/or wherein the lubricating composition includes no more than about 800 ppm of phosphorus from the antiwear system; and/or wherein the lubricating composition includes no more than about 1800 ppm of metal from

the detergent system; and/or wherein the amount of phosphorus from the antiwear system relative to the amount of metal from the detergent system is about 0.5 or less; and/or wherein the amount of phosphorus from the antiwear system relative to the lubricant TBN is effective so that the lubricating composition includes no more than about 0.8 weight percent of calculated sulfated ash and less than about 30 mg of deposits when subjected to the high temperature deposit formation test of ASTM D6335; and/or wherein the detergent system includes about 55 to about 75 weight percent of a detergent additive providing calcium and about 25 to about 45 weight percent of a detergent additive providing magnesium; and/or wherein the detergent system provides about 10 to about 1500 ppm of calcium and about 10 to about 500 ppm magnesium; and/or wherein the antiwear system includes two metal dialkyl dithiophosphates; and/or wherein the antiwear system includes two zinc dialkyl thiophosphates and wherein a first zinc dialkyl dithiophosphate is derived from primary alcohols and a second zinc dialkyl dithiophosphate is derived from secondary alcohols; and/or wherein the antiwear system includes a majority of the second zinc dialkyl dithiophosphate derived from secondary alcohols; and/or wherein the antiwear system includes about 20 to about 30 weight percent of the first zinc dialkyl dithiophosphate derived from primary alcohols and about 70 to about 80 weight percent of the second zinc dialkyl dithiophosphate derived from secondary alcohols; and/or wherein the detergent system includes a calcium sulfonate, calcium phenate, or combination thereof having a total base number of 200 to 500; and/or wherein detergent system includes a magnesium sulfonate, magnesium phenate, or combination thereof having a total base number of 200 to about 500; and/or wherein the total base number of the lubricating composition is less than about 10; and/or further comprising an amount of zinc provided by the antiwear system and wherein an amount of zinc from the antiwear system relative to the amount of total metals from the detergent system is about 0.6 or less; and/or wherein the antiwear system provides about 50 to about 850 ppm of zinc to the lubricating composition; and/or wherein the lubricating composition is a passenger car motor oil.

[0007a] In one aspect, the present disclosure refers to a lubricating composition for reducing high temperature deposits, the lubricating composition comprising: one or more base oils of lubricating viscosity; a detergent system providing an amount of metal to the lubricating composition, where the metal is at least one of sodium, calcium, magnesium, or combinations thereof, wherein the detergent system includes 55 to 75 weight percent of a detergent additive providing calcium and 25 to 45 weight percent of a detergent additive providing magnesium; an antiwear system including one or more metal dialkyl dithiophosphates derived from one of primary alcohols, secondary alcohols, or combinations thereof and providing an amount of phosphorus to the lubricating composition; wherein a total base number (TBN) of the lubricating composition is from 0.5 to 20; wherein a ratio of phosphorus from the antiwear system relative to the TBN of the lubricating composition is 150 or less; wherein the lubricating composition includes a total amount of metal such that the composition has no more than 0.8 weight percent of calculated sulfated ash; and wherein the lubricating composition has less than 30 mg of deposits when subjected to the high temperature deposit formation test of ASTM D6335.

[0008] In another approach or example, a low ash lubricating composition for reducing high temperature deposits is provided herein. In examples, the low ash lubricating composition includes one or more base oil(s) of lubricating viscosity; a detergent system providing an amount of metal to the lubricant composition, where the metal is at least one of sodium, calcium, magnesium, or combinations thereof; an antiwear system including one or more metal dialkyl

dithiophosphates derived from one of primary alcohols, secondary alcohols, or combinations thereof and providing an amount of phosphorus to the lubricating composition; and wherein the amount of phosphorus from the antiwear system relative to the amount of metal from the detergent system is about 0.5 or less.

[0009] The low ash lubricating composition of the previous paragraph may also include one or more optional features or examples. Those optional features or examples may include one or more of the following in any combination: wherein the lubricating composition includes no more than about 800 ppm of phosphorus from the antiwear system and no more than about 1800 ppm of metal from the detergent system; and/or wherein the amount of phosphorus from the antiwear system relative to the TBN is about 120 or less; and/or wherein the amount of phosphorus from the antiwear system relative to the lubricant TBN is effective so that the lubricating composition includes no more than about 0.8 weight percent of calculated sulfated ash and less than about 30 mg of deposits when subjected to the high temperature deposit formation test of ASTM D6335; and/or wherein the detergent system includes about 55 to about 75 weight percent of a detergent additive providing calcium and about 25 to about 45 weight percent of a detergent additive providing magnesium; and/or wherein the detergent system provides about 10 to about 1500 ppm of calcium and about 10 to about 500 ppm magnesium; and/or wherein the antiwear system includes two metal dialkyl dithiophosphates; and/or wherein the antiwear system includes two zinc dialkyl thiophosphates and wherein a first zinc dialkyl dithiophosphate is derived from primary alcohols and a second zinc dialkyl dithiophosphate is derived from secondary alcohols; and/or wherein the antiwear system includes a majority of the second zinc dialkyl dithiophosphate derived from secondary alcohols; and/or wherein the antiwear system includes about 20 to about 30 weight percent of the first zinc dialkyl dithiophosphate derived from primary alcohols and about 70 to about 80 weight percent of the second zinc dialkyl dithiophosphate derived from secondary alcohols; and/or wherein the detergent system includes a calcium sulfonate, calcium phenate, or combination thereof having a total base number of 200 to 500; and/or wherein detergent system includes a magnesium sulfonate, magnesium phenate, or combination thereof having a total base number of 200 to about 500; and/or wherein the total base number of the lubricating composition is less than about 10; and/or further comprising an amount of zinc provided by the antiwear system and wherein an amount of zinc from the antiwear system relative to the amount of total metals from the detergent

system is about 0.6 or less; and/or wherein the antiwear system provides about 50 to about 850 ppm of zinc to the lubricating composition; and/or wherein the lubricating composition is a passenger car motor oil.

[0009a] In one aspect, the present disclosure refers to a low ash lubricating composition for reducing high temperature deposits, the lubricating composition comprising: one or more base oils of lubricating viscosity; a detergent system providing an amount of metal to the lubricant composition, where the metal is at least one of sodium, calcium, magnesium, or combinations thereof, wherein the detergent system includes 55 to 75 weight percent of a detergent additive providing calcium and 25 to 45 weight percent of a detergent additive providing magnesium; an antiwear system including one or more metal dialkyl dithiophosphates derived from one of primary alcohols, secondary alcohols, or combinations thereof and providing an amount of phosphorus to the lubricating composition; wherein a ratio of phosphorus from the antiwear system relative to the amount of metal from the detergent system is 0.5 or less; wherein the lubricating composition includes a total amount of metal such that the composition has no more than 0.8 weight percent of calculated sulfated ash; and wherein the lubricating composition has less than 30 mg of deposits when subjected to the high temperature deposit formation test of ASTM D6335.

[00010] In yet another approach or examples, a method of lubricating an engine with a lubricating composition that meets API SP/ILSAC GF-6 standards. In examples, the method includes lubricating the engine with a lubricating composition, the lubricating composition including one or more base oil(s) of lubricating viscosity; a detergent system providing an amount of metal to the lubricant composition, where the metal is at least one of sodium, calcium, magnesium, or combinations thereof; an antiwear system including one or more metal dialkyl dithiophosphates derived from one of primary alcohol, secondary alcohol, or combinations thereof and providing an amount of phosphorus to the lubricating composition; wherein a total base number (TBN) of the lubricating composition is from about 0.5 to about 20; and wherein the amount of phosphorus from the antiwear system relative to the TBN of the lubricating composition is about 150 or less; and wherein the lubricating composition has no more than about 0.8 weight percent of calculated sulfated ash and less than about 30 mg of deposits when subjected to the high temperature deposit formation test of ASTM D6335.

[00011] In other approaches or examples, the method of the previous paragraph may include optional features, examples, or method steps in any combination. The optional features, examples, or steps may include one or more of the following: wherein the lubricating composition includes no more than about 800 ppm of phosphorus from the antiwear system; and/or wherein the lubricating composition includes no more than about 1800 ppm of total metals from the detergent system; wherein the detergent system provides about 10 to about 1500 ppm of calcium and about 10 to about 500 ppm magnesium; and/or wherein the total base number of the lubricating composition is less than about 10; and/or wherein the antiwear system provides about 50 to about 850 ppm zinc to the lubricating composition and wherein an amount of zinc from the antiwear system relative to the amount of total metals from the detergent system is about 0.6 or less; and/or wherein the amount of phosphorus from the antiwear system relative to the TBN is about 120 or less; and/or wherein the amount of phosphorus from the antiwear system relative to the lubricant TBN is effective so that the lubricating composition includes no more than about 0.8 weight percent of calculated sulfated ash and less than about 30 mg of deposits when subjected to the high temperature deposit formation test of ASTM D6335; and/or

wherein the detergent system includes about 55 to about 75 weight percent of a detergent additive providing calcium and about 25 to about 45 weight percent of a detergent additive providing magnesium; and/or wherein the detergent system provides about 10 to about 1500 ppm of calcium and about 10 to about 500 ppm magnesium; and/or wherein the antiwear system includes two metal dialkyl dithiophosphates; and/or wherein the antiwear system includes two zinc dialkyl thiophosphates and wherein a first zinc dialkyl dithiophosphate is derived from primary alcohols and a second zinc dialkyl dithiophosphate is derived from secondary alcohols; and/or wherein the antiwear system includes a majority of the second zinc dialkyl dithiophosphate derived from secondary alcohols; and/or wherein the antiwear system includes about 20 to about 30 weight percent of the first zinc dialkyl dithiophosphate derived from primary alcohols and about 70 to about 80 weight percent of the second zinc dialkyl dithiophosphate derived from secondary alcohols; and/or wherein the detergent system includes a calcium sulfonate, calcium phenate, or combination thereof having a total base number of 200 to 500; and/or wherein detergent system includes a magnesium sulfonate, magnesium phenate, or combination thereof having a total base number of 200 to about 500; and/or wherein the total base number of the lubricating composition is less than about 10; and/or further comprising an amount of zinc provided by the antiwear system and wherein an amount of zinc from the antiwear system relative to the amount of total metals from the detergent system is about 0.6 or less; and/or wherein the antiwear system provides about 50 to about 850 ppm of zinc to the lubricating composition; and/or wherein the lubricating composition is a passenger car motor oil.

[00011a] In one aspect, the present disclosure refers to a method of lubricating an engine with a lubricating composition that meets API SP/ILSAC GF-6 standards, the method comprising lubricating the engine with a lubricating composition, the lubricating composition including one or more base oils of lubricating viscosity; a detergent system providing an amount of metal to the lubricant composition, where the metal is at least one of sodium, calcium, magnesium, or combinations thereof, wherein the detergent system includes 55 to 75 weight percent of a detergent additive providing calcium and 25 to 45 weight percent of a detergent additive providing magnesium; an antiwear system including one or more metal dialkyl dithiophosphates derived from one of primary alcohol, secondary alcohol, or combinations thereof and providing an amount of phosphorus to the lubricating composition; wherein a total base number (TBN) of the lubricating composition is from 0.5 to 20; and wherein a ratio of phosphorus from the antiwear system relative to the TBN of the lubricating composition is 150 or less; and wherein the lubricating composition has a total amount of metals such that the lubricating composition has no more than 0.8 weight percent of calculated sulfated ash and less than 30 mg of deposits when subjected to the high temperature deposit formation test of ASTM D6335.

[00012] In another approach or example, use of any example of the lubricating compositions of this Summary is provided for achieving less than 30 mg of deposits when subjected to the high temperature deposit formation test of ASTM D6335.

[00013] In other examples herein, any of the examples of the use, methods, or compositions herein may have a calculated sulfated ash (SASH) as calculated by the methods set forth below of less than about 0.8 weight percent, less than about 0.75 weight percent, less than about 0.7 weight percent, less than about 0.6 weight percent, less than about 0.5 weight percent, less than about 0.4 weight percent, less than about 0.3 weight percent, or even less than about 0.2 weight percent.

[00014] Other examples of the present disclosure will be apparent to those skilled in the art from consideration of the specification and practice of the disclosure disclosed herein. The

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

[00026] As used herein, “post-reacted” or “post-treated” refers to a component that is further reacted with or treated with, for example, a boron, phosphorus, and/or maleic anhydride and may refer to dispersants in which primary and/or secondary amines are further reacted with such compounds to convert at least a portion of such amines to tertiary amines. Such subsequent reactions or treatments are further described in US 5,241,003, which is incorporated herein by reference. Conversely, components that are “not post-reacted” or “not post-treated” have not been subjected to such further processing, reactions, and/or treatments and, in the context of dispersants, include a certain amount of primary and/or secondary amines.

[00027] The molecular weight for any example herein may be determined with a gel permeation chromatography (GPC) instrument obtained from Waters or the like instrument and the data processed with Waters Empower Software or the like software. The GPC instrument may be equipped with a Waters Separations Module and Waters Refractive Index detector (or the like optional equipment). The GPC operating conditions may include a guard column, 4 Agilent PLgel columns (length of 300×7.5 mm; particle size of 5 μ, and pore size ranging from 100-10000 Å) with the column temperature at about 40 °C. Un-stabilized HPLC grade tetrahydrofuran (THF) may be used as solvent, at a flow rate of 1.0 mL/min. The GPC instrument may be calibrated with commercially available polystyrene (PS) standards having a narrow molecular weight distribution ranging from 500 – 380,000 g/mol. The calibration curve can be extrapolated for samples having a mass less than 500 g/mol. Samples and PS standards can be in dissolved in THF and prepared at concentration of 0.1 to 0.5 wt. % and used without filtration. GPC measurements are also described in US 5,266,223, which is incorporated herein by reference. The GPC method additionally provides molecular weight distribution information; *see, for example*, W. W. Yau, J. J. Kirkland and D. D. Bly, “Modern Size Exclusion Liquid Chromatography”, John Wiley and Sons, New York, 1979, also incorporated herein by reference.

CLAIMS

WHAT IS CLAIMED IS

1. A lubricating composition for reducing high temperature deposits, the lubricating composition comprising:

one or more base oils of lubricating viscosity;

a detergent system providing an amount of metal to the lubricating composition, where the metal is at least one of sodium, calcium, magnesium, or combinations thereof, wherein the detergent system includes 55 to 75 weight percent of a detergent additive providing calcium and 25 to 45 weight percent of a detergent additive providing magnesium;

an antiwear system including one or more metal dialkyl dithiophosphates derived from one of primary alcohols, secondary alcohols, or combinations thereof and providing an amount of phosphorus to the lubricating composition;

wherein a total base number (TBN) of the lubricating composition is from 0.5 to 20;

wherein a ratio of phosphorus from the antiwear system relative to the TBN of the lubricating composition is 150 or less;

wherein the lubricating composition includes a total amount of metal such that the composition has no more than 0.8 weight percent of calculated sulfated ash; and

wherein the lubricating composition has less than 30 mg of deposits when subjected to the high temperature deposit formation test of ASTM D6335.

2. The lubricating composition of claim 1, wherein the ratio of phosphorus from the antiwear system relative to the TBN is 120 or less; and/or wherein a ratio of phosphorus from the antiwear system relative to the amount of metal from the detergent system is 0.5 or less.

3. The lubricating composition of claim 2, wherein the lubricating composition includes no more than 800 ppm of phosphorus from the antiwear system.

4. The lubricating composition of claim 3, wherein the lubricating composition includes no more than 1800 ppm of metal from the detergent system.

5. The lubricating composition of claim 1, wherein the detergent system provides 10 to 1500 ppm of calcium and 10 to 500 ppm magnesium.

6. The lubricating composition of claim 1, wherein the antiwear system includes two metal dialkyl dithiophosphates; and/or wherein a first zinc dialkyl dithiophosphate is derived from primary alcohols and a second zinc dialkyl dithiophosphate is derived from secondary alcohols.

7. The lubricating composition of claim 6, wherein the antiwear system includes a majority of the second zinc dialkyl dithiophosphate derived from secondary alcohols; and/or wherein the antiwear system includes 20 to 30 weight percent of the first zinc dialkyl dithiophosphate derived from primary alcohols and 70 to 80 weight percent of the second zinc dialkyl dithiophosphate derived from secondary alcohols.

8. The lubricating composition of claim 1, wherein the detergent system includes a calcium sulfonate, calcium phenate, or combination thereof having a total base number of 200 to 500; and/or wherein detergent system includes a magnesium sulfonate, magnesium phenate, or combination thereof having a total base number of 200 to 500; and/or wherein the total base number of the lubricating composition is less than 10.

9. The lubricating composition of claim 1, further comprising an amount of zinc provided by the antiwear system and wherein an amount of zinc from the antiwear system relative to the amount of total metals from the detergent system is 0.6 or less; and/or wherein the antiwear system provides 50 to 850 ppm of zinc to the lubricating composition.

10. A low ash lubricating composition for reducing high temperature deposits, the lubricating composition comprising:

one or more base oils of lubricating viscosity;

a detergent system providing an amount of metal to the lubricant composition, where the metal is at least one of sodium, calcium, magnesium, or combinations thereof, wherein the

detergent system includes 55 to 75 weight percent of a detergent additive providing calcium and 25 to 45 weight percent of a detergent additive providing magnesium;

an antiwear system including one or more metal dialkyl dithiophosphates derived from one of primary alcohols, secondary alcohols, or combinations thereof and providing an amount of phosphorus to the lubricating composition;

wherein a ratio of phosphorus from the antiwear system relative to the amount of metal from the detergent system is 0.5 or less;

wherein the lubricating composition includes a total amount of metal such that the composition has no more than 0.8 weight percent of calculated sulfated ash; and

wherein the lubricating composition has less than 30 mg of deposits when subjected to the high temperature deposit formation test of ASTM D6335.

11. The low ash lubricating composition of claim 10, wherein the lubricating composition includes no more than 800 ppm of phosphorus from the antiwear system and no more than 1800 ppm of metal from the detergent system.

12. A method of lubricating an engine with a lubricating composition that meets API SP/ILSAC GF-6 standards, the method comprising

lubricating the engine with a lubricating composition, the lubricating composition including one or more base oils of lubricating viscosity; a detergent system providing an amount of metal to the lubricant composition, where the metal is at least one of sodium, calcium, magnesium, or combinations thereof, wherein the detergent system includes 55 to 75 weight percent of a detergent additive providing calcium and 25 to 45 weight percent of a detergent additive providing magnesium; an antiwear system including one or more metal dialkyl dithiophosphates derived from one of primary alcohol, secondary alcohol, or combinations thereof and providing an amount of phosphorus to the lubricating composition; wherein a total base number (TBN) of the lubricating composition is from 0.5 to 20; and wherein a ratio of phosphorus from the antiwear system relative to the TBN of the lubricating composition is 150 or less; and

wherein the lubricating composition has a total amount of metals such that the lubricating composition has no more than 0.8 weight percent of calculated sulfated ash and less than 30 mg of deposits when subjected to the high temperature deposit formation test of ASTM D6335.

13. The method of claim 12, wherein the lubricating composition includes no more than 800 ppm of phosphorus from the antiwear system; and/or wherein the lubricating composition includes no more than 1800 ppm of total metals from the detergent system; and/or wherein the detergent system provides 10 to 1500 ppm of calcium and 10 to 500 ppm magnesium.

14. The method of claim 12, wherein the antiwear system provides 50 to 850 ppm zinc to the lubricating composition and wherein an amount of zinc from the antiwear system relative to the amount of total metals from the detergent system is 0.6 or less.