BRIEF DESCRIPTION OF THE FIGURES

[0005] FIGS. 1 and 2 are graphs of percent viscosity increase (KV100) after 144 hours of oxidization pursuant to GFC Lu-43-A-11; and

[0006] FIG. 3 is a plot of viscosity increase (KV100) over time pursuant to GFC Lu-43-A-11.

SUMMARY

[0007] The present disclosure relates to lubricating compositions for maintaining a stable viscosity and minimizing oxidative degradation of the lubricant that contains an oil of lubricating viscosity contaminated with a biodiesel fuel. In one example, the lubricating composition includes one or more base oils of lubricating viscosity; sulfurized additives providing at least about 1,500 ppm of sulfur to the lubricating composition; one or more boronated dispersants providing about 40 ppm or more boron to the lubricating composition; a detergent system providing about 0.2 to about 1.0 weight percent soap content to the lubricating composition (in other approaches, about 0.2 to about 0.8 weight percent) and providing magnesium, sodium, and calcium. In some approaches or examples, the detergent system provides greater than about 90 ppm of sodium and no more than about 2,500 ppm of magnesium to the lubricating composition, and wherein the detergent system has a weight ratio of sodium-to-magnesium of at least about 0.1, and a weight ratio of sulfur-to-sodium of about 15 or less; and the lubricating composition is contaminated with up to about 30 weight percent of biodiesel fuel.

[0008] The lubricating composition of the previous paragraph may also be combined with one or more optional features or examples in any combination. Such optional features or examples may include one or more of the following: wherein the lubricating composition includes about 90 ppm to about 1,000 ppm of sodium, about 500 ppm to about 2,000 ppm of calcium, about 100 to about 1,000 ppm of magnesium, and/or about 1,500 to about 4,000 ppm of sulfur; and/or wherein the lubricating composition has a weight ratio of calcium-to-magnesium of at least about 0.5, and/or wherein about 15 to about 25 weight percent of the sulfur is provided by a sulfurized olefin antioxidant; and/or wherein the lubricating composition exhibits a viscosity increase upon oxidization when tested pursuant to the GFC Lu-43-A-11 test after 144 hours of no greater than about 150 percent; and/or wherein the viscosity increase of the lubricating composition after 144 hours is up to about 50 percent more than the viscosity increase of a lubricating composition without the biodiesel

contamination after 144 hours; and/or wherein the soap content is a sulfonate soap, a phenate soap, or combination thereof and preferably a sulfonate soap; and/or wherein the lubricating composition includes at least about 0.1 weight percent to about 5.0 weight percent of a linear or branched sodium sulfonate (in other approaches, about 0.25 to about 5.0 weight percent); and/or wherein the lubricating composition has no more than about 500 ppm of boron; and/or wherein the ratio of sodium-to-magnesium is about 0.1 to about 2.0; and/or wherein the base oil of lubricating viscosity includes an API Group I base oil, an API Group II base oil, an API Group III base oil, an API Group IV base oil, an API Group V base oil, or combinations thereof; and/or wherein the base oil of lubricating viscosity is an API Group III base oil; and/or wherein the lubricating composition is substantially free of phenolic antioxidants; and/or further comprising an aminic antioxidant; and/or wherein the aminic antioxidant is selected from the group comprising aromatic amines, alkylated diphenyl amines, nonyl diphenylamine, di-nonyl diphenylamine, octyl diphenylamine, di-octyl diphenylamine, phenyl-alpha-naphthylamines, alkylated phenyl-alpha-naphthylamines, hindered non-aromatic amines, or combinations thereof; and/or further comprising molybdenum and no more than about 400 ppm of molybdenum; and/or further comprising phosphorus and no more than about 1,200 ppm of phosphorus; and/or further comprising a friction modifier provided by imidazolines, amides, amines, succinimides, alkoxylated amines, alkoxylated ether amines, amine oxides, amidoamines, nitriles, betaines, quaternary amines, imines, amine salts, amino guanadine, alkanolamides, phosphonates, metal-containing compounds, glycerol esters, sulfurized fatty compounds and olefins, fatty acids, dicarboxylic acid esters, esters or partial esters of a polyol and one or more aliphatic or aromatic carboxylic acids, or combinations thereof; and/or wherein the lubricating composition includes neutral or overbased magnesium sulfonate, sodium sulfonate, and calcium sulfonate with a total base number (TBN) of each being up to about 500; and/or wherein the lubricating composition includes a neutral or overbased metal phenate with a total base number (TBN) of up to about 500.

[0008a] In one aspect, the present disclosure refers to a lubricating composition comprising: one or more base oils of lubricating viscosity; sulfurized additives providing at least about 1,500 ppm of sulfur to the lubricating composition; one or more boronated dispersants providing about 40 ppm to about 500 ppm boron to the lubricating composition; a detergent system providing about 0.2 to about 1.0 weight percent soap content to the lubricating composition and providing magnesium, sodium, and calcium, wherein the detergent system provides greater than about 90 ppm of sodium and no more than about 1,000 ppm of magnesium to the lubricating composition, and wherein the detergent system has a weight ratio of sodium-to-magnesium of about 0.4 to 2.0, and a weight ratio of sulfur-to-sodium of about 12 or less; wherein the lubricating composition is contaminated with up to about 30 weight percent of biodiesel fuel and wherein the lubricating composition exhibits viscosity stability upon oxidization when tested pursuant to GFC Lu-43-A-11; and wherein the lubricating composition includes about 90 ppm to about 1,000 ppm of sodium, about 500 ppm to about 2,000 ppm of calcium, about 100 to about 1,000 ppm of magnesium, about 1,500 to about 4,000 ppm of sulfur, and a weight ratio of calcium-to-magnesium of about 0.5 to about 2.5.

[0009] In yet other approaches, the use of any example of the lubricating compositions and/or the detergent systems thereof as described in the previous paragraphs is described herein for maintaining a viscosity increase upon oxidization when tested pursuant to the GFC Lu-43-A-11 test after 144 hours of no greater than about 150 percent.

[0010] In yet further approaches, a method of maintaining a stable viscosity in a lubricating composition upon oxidization is provided herein. In examples, the method includes

performing an oxidization test pursuant to GFC Lu-43-A-11 on a lubricating composition and wherein the lubricating composition including one or more base oils of lubricating viscosity, sulfurized additives providing at least about 1,500 ppm sulfur, one or more boronated dispersants providing about 40 ppm or more of boron, and a detergent system providing about 0.2 to about 1.0 weight percent soap to the lubricating composition (in other approaches, about 0.2 to about 0.8 weight percent soap content) and providing magnesium, sodium, and calcium, wherein the detergent system provides greater than about 90 ppm of sodium and no more than about 2,500 ppm of magnesium to the lubricating composition, and wherein the detergent system has a weight ratio of sodium-to-magnesium of at least about 0.1, and a weight ratio of sulfur-to-sodium of about 15 or less; and wherein the lubricating composition exhibits a viscosity increase upon oxidization after 144 hours of no greater than about 150 percent.

[0011] In yet other approaches or examples, the methods of the previous paragraph may also be combined with one or more optional features, method steps or examples in any combination. Such optional features, method steps, or examples may include one or more of the following: wherein the lubricating composition includes about 90 ppm to about 1,000 ppm of sodium, about 500 ppm to about 2,000 ppm of calcium, about 100 to about 1,000 ppm of magnesium, and/or about 1,500 to about 4,000 ppm of sulfur; and/or wherein the lubricating composition has a weight ratio of calcium-to-magnesium of at least about 0.5; and/or wherein about 15 to about 25 weight percent of the sulfur is provided by a sulfurized olefin antioxidant; and/or wherein the lubricating composition exhibits a viscosity increase upon oxidization when tested pursuant to the GFC Lu-43-A-11 test after 144 hours of no greater than about 150 percent; and/or wherein the viscosity increase of the lubricating composition after 144 hours is up to about 50 percent more than the viscosity increase of a lubricating composition without the biodiesel contamination after 144 hours; and/or wherein the soap content is a sulfonate soap, a phenate soap, or combination thereof and preferably a sulfonate soap; and/or wherein the lubricating composition includes at least about 0.1 weight percent to about 5.0 weight percent of a linear or branched sodium sulfonate (in other approaches, about 0.25 to about 5.0 weight percent); and/or wherein the lubricating composition has no more than about 500 ppm of boron; and/or wherein the ratio of sodium-to-magnesium is about 0.1 to about 2.0; and/or wherein the base oil of lubricating viscosity includes an API Group I base oil, an API Group II base oil, an API Group III base oil, an API Group IV base oil, an API Group V base oil, or combinations thereof; and/or wherein the

base oil of lubricating viscosity is an API Group III base oil; and/or wherein the lubricating composition is substantially free of phenolic antioxidants; and/or further comprising an aminic antioxidant; and/or wherein the aminic antioxidant is selected from the group comprising aromatic amines, alkylated diphenyl amines, nonyl diphenylamine, di-nonyl diphenylamine, octyl diphenylamine, di-octyl diphenylamine, phenyl-alpha-naphthylamines, alkylated phenyl-alpha-naphthylamines, hindered non-aromatic amines, or combinations thereof; and/or further comprising molybdenum and no more than about 400 ppm of molybdenum; and/or further comprising phosphorus and no more than about 1,200 ppm of phosphorus; and/or further comprising a friction modifier provided by imidazolines, amides, amines, succinimides, alkoxylated amines, alkoxylated ether amines, amine oxides, amidoamines, nitriles, betaines, quaternary amines, imines, amine salts, amino guanadine, alkanolamides, phosphonates, metal-containing compounds, glycerol esters, sulfurized fatty compounds and olefins, fatty acids, dicarboxylic acid esters, esters or partial esters of a polyol and one or more aliphatic or aromatic carboxylic acids, or combinations thereof; and/or wherein the lubricating composition includes neutral or overbased magnesium sulfonate, sodium sulfonate, and calcium sulfonate with a total base number (TBN) of each being up to about 500; and/or wherein the lubricating composition includes a neutral or overbased metal phenate with a total base number (TBN) of up to about 500.

[0011a] In one aspect, the present disclosure refers to a method of maintaining a stable viscosity in a lubricating composition upon oxidization, the method comprising: performing an oxidization test pursuant to GFC Lu-43-A-11 on a lubricating composition; the lubricating composition including one or more base oils of lubricating viscosity, sulfurized additives providing at least about 1,500 ppm sulfur, one or more boronated dispersants providing about 40 ppm to about 500 ppm of boron, and a detergent system providing about 0.2 to about 1.0 weight percent soap to the lubricating composition and providing magnesium, sodium, and calcium, wherein the detergent system provides greater than about 90 ppm of sodium and no more than about 1,000 ppm of magnesium to the lubricating composition, and wherein the detergent system has a weight ratio of sodium-to-magnesium of about 0.4 to 2.0, and a weight ratio of sulfur-to-sodium of about 12 or less; wherein the lubricating composition exhibits a viscosity increase upon oxidization after 144 hours of no greater than about 150 percent when tested pursuant to GFC Lu-43-A-11; and wherein the lubricating composition includes about 90 ppm to about 1,000 ppm of sodium, about 500 ppm to about 2,000 ppm of calcium, about 100 to about 1,000 ppm of magnesium, about 1,500 to about 4,000 ppm of sulfur, and a weight ratio of calcium-to-magnesium of about 0.5 to about 2.5.

DETAILED DESCRIPTION

[0012] The present disclosure relates to lubricating compositions and methods of lubricating an internal combustion engine effective to maintain a stable viscosity and/or minimize oxidative degradation in the context of viscosity increase of the lubricant when the lubricant (1) includes an oil of lubricating viscosity contaminated with a biodiesel fuel and (2) includes one or more additives known to negatively impact oxidative viscosity increase. In one approach or embodiment, a lubricating composition is described herein with one or more base oils of lubricating viscosity, sulfurized additives providing at least about 1,500 ppm of sulfur to the lubricating composition, one or more boronated dispersants providing about 40 ppm or more boron to the lubricating composition, and wherein the lubricating composition is contaminated with up to about 30 weight percent of biodiesel fuel. Such lubricating combinations tend to fail industry performance standards relating to oxidative viscosity stability.