PHOSPHORYLATED DISPERSANTS IN FLUIDS FOR ELECTRIC VEHICLES

FIELD

[001] The present disclosure relates to a lubricating fluid for an electric motor system and a method of lubricating gears and cooling a motor in an electric motor system. In particular, the disclosed technology relates to a lubricating fluid, for use in electric motor vehicle, comprising an oil of lubricating viscosity, at least one phosphorylated dispersant having between 2.0 wt% and 3.5 wt% of phosphorus. The lubricating fluid has a resistivity after aging of at least 50 MΩ.m, as measured by a modified version of ASTM D2624-15 at 30°C.

BACKGROUND

[002] A major challenge in developing electric vehicle powertrain lubricants is achieving wear performance, inhibiting copper corrosion, and ensuring lubricant compatibility with electrified components in the powertrain over the lifetime of the lubricant. For example, gears within the electric vehicle powertrain require good wear protection. Further, copper present in the electrified components of an electric motor require protection at high temperatures. Additionally, the lubricant electrical resistivity needs to remain relatively high over the lifetime of the lubricant to inhibit electrostatic buildup and discharge in the electrified components.

[003] Despite advances in lubricant technology for electric vehicle powertrains, there is a need for an electric vehicle powertrain lubricant composition having desired wear performance, copper corrosion compatibility, and lubricant electrical resistivity.

SUMMARY AND TERMS

[003a] In a first aspect of the present disclosure, there is provided an additive concentrate and base oil composition, the additive concentrate and base oil composition comprising:

an additive concentrate including a phosphorylated succinimide dispersant containing 2.8 wt% to 3.5 wt% phosphorus, the phosphorylated succinimide dispersant in an amount to provide 100 ppm to 650 ppm phosphorus, and wherein the phosphorylated succinimide dispersant provides at least 70% of the total phosphorus in the additive concentrate, and wherein the phosphorylated succinimide dispersant is the reaction product of a succinimide dispersant and a

phosphorus source including full and partial esters of phosphorus acids, phosphorus halide compounds, mono-, di-, and tri-esters of phosphoric acid, and combinations thereof; and

a base oil selected from a API Group III base oil or blends of a Group III base oil with a Group II base oil, a Group V base oil, or mixtures thereof,

a kinematic viscosity from 3 cSt to 6.5 cSt at 100°C,

a resistivity of at least 50 M Ω·m, as measured according to ASTM D2624-15 using the lubricating composition at 1.5 volts and at 30°C, after the fluid has been aged according to JIS K2514-1 at 150°C,

2 to 31 ppm of copper after 120 hours at 150°C pursuant to ASTM D130-18,

a 4-ball wear scar of 0.423 to 0.680 mm pursuant to ASTM D4172; and

if the base oil includes an API Group V base oil, then the additive concentrate is blended with up to 15 wt% of the API Group V base oil; and

if the base oil includes an API Group II base oil, then the additive concentrate is blended with up to 80 wt% of the API Group II base oil.

[004] In one example, a lubricating composition for use in an electric vehicle or a hybrid electric vehicle is described herein. In one example, the lubricating composition includes at least 95 weight percent of a lubricating base oil composition, the lubricating base oil composition including base oil selected from API Group III base oils or blends of Group III base oils with Group II, Group V base oils or mixtures thereof; a phosphorylated succinimide dispersant containing 2 wt% to 3.5 wt% phosphorus, the phosphorylated succinimide dispersant providing 650 ppm or less phosphorus to the lubricating composition; the lubricating composition having 700 ppm or less total phosphorus and the phosphorylated succinimide dispersant provides at least 70% of the total phosphorus; and wherein the lubricating

composition has a kinematic viscosity from 3 cSt to 6.5 cSt at 100°C and has a resistivity of at least 50 M Ω·m, as measured according to ASTM D2624-15 using the lubricating composition at 1.5 volts and at 30°C, after the fluid has been aged according to JIS K2514-1 at 150°C; wherein if the lubricating base oil composition comprises API Group V base oil, the API Group V base oil is present in an amount up to 15 wt% based on the total lubricating composition; wherein if the lubricating base oil composition comprises API Group II base oil, the API Group II is present in an amount up to 80 wt% base on the total lubricating composition.

[005] In other examples, the lubricating composition may further include wherein the phosphorylated succinimide dispersant is a first dispersant and wherein the composition further comprises a second dispersant containing 0.2 wt% to 0.4 wt% phosphorus, the second dispersant providing 50 ppm or less phosphorus to the lubricating composition; and/or wherein the phosphorylated succinimide dispersant contains 2.5 wt% to 3.0 wt% phosphorus.

[006] In yet other examples, any lubricating composition herein may include the phosphorylated succinimide dispersant to provide 115 ppm to 600 ppm phosphorus to the lubricating composition' and/or the phosphorylated succinimide dispersant provides 115 ppm to 250 ppm phosphorus to the lubricating composition; and/or the first dispersant delivers 115 ppm to 250 ppm of phosphorus to the lubricating composition and the second dispersant delivers 40 ppm or less of phosphorus to the lubricating composition; and/or wherein the phosphorylated succinimide dispersant provides 250 ppm or less phosphorus to the lubricating composition and wherein the lubricating composition has 300 ppm or less total phosphorus.

[007] In yet other examples, any lubricating composition herein may have a resistivity of at least 115 M Ω·m after the fluid has been aged according to JIS K2514-1 at 150°C.

[008] In other examples, any lubricating composition herein may have a base oil composition is selected from API Group III base oils or API Group II base oils combined with mixtures of API Group II and Group III base oils.

[009] In another example, any lubricating composition herein may include the phosphorylated succinimide dispersant to provide between 115 ppm and 250 ppm phosphorus to the lubricating composition; and the lubricating composition has between 160 ppm and 300 ppm total phosphorus, a kinematic viscosity from 5.5 cSt to 6.0 cSt at 100°C, and a resistivity of at least 115 M Ω·m after the fluid has been aged according to JIS K2514-1 at 150°C.

[010] In another example of the present disclosure, a method of improving electrical resistivity of a lubricating composition in an electric or hybrid electric vehicle is provided. In one approach, the method includes providing to an electric or hybrid electric vehicle powertrain a lubricating oil having a composition comprising at least 95 weight percent of a lubricating base oil composition, the lubricating base oil composition comprising base oil selected from API Group III base oils or blends of API Group III base oils with API Group II, API Group V base oils, or mixtures thereof; a phosphorylated succinimide dispersant containing 2 wt% to 3.5 wt% phosphorus, the phosphorylated succinimide dispersant providing 650 ppm or less phosphorus to the lubricating composition; the lubricating composition having 700 ppm or less phosphorus and the phosphorylated succinimide dispersant provides at least 70% of the total phosphorus; and wherein the lubricating oil has a kinematic viscosity from 3 cSt to 6.5 cSt at 100°C and has a resistivity of at least 50 M Ω·m, as measured according to ASTM D2624-15 using the lubricating composition at 1.5 volts and at 30°C, after the fluid has been aged according to JIS K2514-1 at 150°C; and wherein if the lubricating base oil composition comprises API Group V base oil, the API Group V base oil is present in an amount up to 15 wt% based on the total lubricating composition; and wherein if the lubricating base oil composition comprises API Group II base oil, the API Group II is present in an amount up to 80 wt% base on the total lubricating composition.

[011] In other examples of the methods, the phosphorylated succinimide dispersant is a first dispersant and wherein the composition further comprises a second dispersant containing 0.2 wt% to 0.4 wt% phosphorus, the second dispersant providing 50 ppm or less phosphorus to the lubricating composition; and/or wherein the phosphorylated succinimide dispersant contains 2.5 wt% to 3.0 wt% phosphorus.

[012] In yet other examples of any method herein, the phosphorylated succinimide dispersant provides 115 ppm to 600 ppm phosphorus to the lubricating composition; and/or the phosphorylated succinimide dispersant provides 115 ppm to 250 ppm phosphorus to the lubricating composition; and/or the first dispersant delivers 115 ppm to 250 ppm of phosphorus to the lubricating composition and the second dispersant delivers 40 ppm or less phosphorus to the lubricating composition; and/or the phosphorylated succinimide dispersant provides 250 ppm or less phosphorus to the lubricating composition and wherein the lubricating composition has 300 ppm or less total phosphorus.

[013] In yet further examples of any method, the lubricating composition has resistivity of at least 115 M Ω·m after the fluid has been aged according to JIS K2514-1 at 150°C; and/or the base oil composition is selected from API Group III base oils or blends of API Group II and III base oils or mixtures thereof; and/or the phosphorylated succinimide dispersant provides 115 ppm to 250 ppm phosphorus to the lubricating composition and the lubricating composition has 160 ppm to 300 ppm total phosphorus, a kinematic viscosity from 5.5 cSt to 6.0 cSt at 100°C, and a resistivity of at least 115 M Ω·m after the fluid has been aged according to JIS K2514-1 at 150°C.

[014] In yet other examples, the present disclosure provides a use, in a hybrid or electric vehicle, of a lubricating composition comprising a phosphorylated succinimide dispersant for improving electrical resistivity durability of a lubricating composition, wherein the lubricating composition is described in any example above and herein. In other examples, a use is provided, in a hybrid or electric vehicle, of a lubricating composition comprising a phosphorylated succinimide dispersant as described in any example herein for achieving a resistivity of at least 50 M Ω·m after the fluid has been aged according to JIS K2514-1 at 150°C. In yet further examples, a use is described, in a hybrid or electric vehicle, of a lubricating composition comprising a phosphorylated succinimide dispersant as described in any example herein for achieving at least one or more of a resistivity of at least 50 M Ω·m after the fluid has been aged according to JIS K2514-1 at 150°C, for reducing wear scar, and/or for reducing copper corrosivity of the lubricating composition.

[015] 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.

[016] The following definitions of terms are provided in order to clarify the meanings of certain terms as used herein.

[017] The terms “lubricating oil,” “lubricant composition,” “lubricating composition,” “lubricant” and “lubricating and cooling fluid” refer to a finished lubrication product comprising a major amount of a base oil plus a minor amount of an additive composition.

[018] As used herein, the terms “additive package,” “additive concentrate,” “additive composition,” and “transmission fluid additive package” refer the portion of the lubricating oil composition excluding the major amount of base oil.

ingredient not explicitly listed. The phrase "consists essentially of" is meant to include any expressly listed element, step, or ingredient and any additional elements, steps, or ingredients that do not materially affect the basic and novel examples of the disclosure. The present disclosure also contemplates that any composition described using the terms, "comprises," "includes," “contains,” is also to be interpreted as including a disclosure of the same composition "consisting essentially of" or “consisting of” the specifically listed components thereof.

DETAILED DESCRIPTION

[027] According to an exemplary embodiment, a lubricating fluid for use in an electric or hybrid electric vehicle is described herein that contains base oil and at least one phosphorylated succinimide dispersant having 2.0 wt% to 3.5 wt% of phosphorus. In one embodiment, the phosphorylated succinimide dispersant having 2.0 wt% to 3.5 wt% of phosphorus delivers less than 650 ppm phosphorus to the lubricating fluid. In other embodiments, the phosphorylated succinimide dispersant has 2.5 wt% to 3.2 wt% phosphorus, in yet other embodiments, 2.8 wt% to 3.2 wt% phosphorus, and in yet further embodiments, about 3 wt% phosphorus. In any embodiment herein, the phosphorylated succinimide dispersant may provide up to 650 ppm phosphorus to the fluid, up to 600 ppm phosphorus to the fluid, up to 500 ppm phosphorus, up to 400 ppm phosphorus, up to 300 ppm phosphorus, or up to 250 ppm phosphorus. In other embodiments, the phosphorylated succinimide dispersant may provide at least 100 ppm phosphorus, at least 120 ppm phosphorus, or at least 150 ppm phosphorus to the fluids herein.

[028] The fluids herein may also contain other sources of phosphorus, but the total phosphorus content of the fluid may be 700 ppm or less, 650 ppm or less, 600 ppm or less, 550 ppm or less, 500 ppm or less, 450 ppm or less, 400 ppm or less, 350 ppm or less, 300 ppm or less, 250 ppm or less, or 200 ppm or less. The fluids may also include 100 ppm or more of total phosphorus. In embodiments with other sources of phosphorus, the phosphorus provided from the phosphorylated succinimide dispersant provides at least about 70% of the total phosphorus, at least about 75%, at least about 80%, at least about 90%, or even at least about 92% of the total phosphorus in the fluid. In other approaches, the phosphorus provided by the phosphorylated succinimide dispersant provides 100% or less of the total phosphorus, 98% or less, 95% or less, or 90% or less of the total phosphorus.

[029] As discussed more below, the fluids herein with the base oils and the at least one phosphorylated succinimide dispersant generally has a kinematic viscosity from 3 cSt to 6.5 cSt

WHAT IS CLAIMED IS:

1. An additive concentrate and base oil composition, the additive concentrate and base oil composition comprising:

an additive concentrate including a phosphorylated succinimide dispersant containing 2.8 wt% to 3.5 wt% phosphorus, the phosphorylated succinimide dispersant in an amount to provide 100 ppm to 650 ppm phosphorus, and wherein the phosphorylated succinimide dispersant provides at least 70% of the total phosphorus in the additive concentrate, and wherein the phosphorylated succinimide dispersant is the reaction product of a succinimide dispersant and a phosphorus source including full and partial esters of phosphorus acids, phosphorus halide compounds, mono-, di-, and tri-esters of phosphoric acid, and combinations thereof; and

a base oil selected from a API Group III base oil or blends of a Group III base oil with a Group II base oil, a Group V base oil, or mixtures thereof,

a kinematic viscosity from 3 cSt to 6.5 cSt at 100°C,

a resistivity of at least 50 M Ω·m, as measured according to ASTM D2624-15 using the lubricating composition at 1.5 volts and at 30°C, after the fluid has been aged according to JIS K2514-1 at 150°C,

2 to 31 ppm of copper after 120 hours at 150°C pursuant to ASTM D130-18,

a 4-ball wear scar of 0.423 to 0.680 mm pursuant to ASTM D4172; and

if the base oil includes an API Group V base oil, then the additive concentrate is blended with up to 15 wt% of the API Group V base oil; and

if the base oil includes an API Group II base oil, then the additive concentrate is blended with up to 80 wt% of the API Group II base oil.

2. The additive concentrate and base oil composition of claim 1, wherein the phosphorylated succinimide dispersant contains 2.8 wt% to 3.0 wt% phosphorus.

3. The additive concentrate and base oil composition of claim 2, wherein the phosphorylated succinimide dispersant provides 115 ppm to 600 ppm phosphorus.

4. The additive concentrate and base oil composition of claim 3, wherein the phosphorylated succinimide dispersant provides 115 ppm to 250 ppm phosphorus.

5. The additive concentrate and base oil composition of claim 1, wherein the phosphorylated succinimide dispersant provides 250 ppm or less phosphorus.

6. The additive concentrate and base oil composition of claim 1, wherein the resistivity is at least 115 M Ω·m after the fluid has been aged according to JIS K2514-1 at 150°C.

7. The additive concentrate and base oil composition of claim 1, wherein the base oil is selected from API Group III base oils or mixtures of API Group II and Group III base oils.

8. The additive concentrate and base oil composition of claim 7, wherein the phosphorylated succinimide dispersant provides between 115 ppm and 250 ppm phosphorus, a kinematic viscosity from 5.5 cSt to 6.0 cSt at 100°C, and a resistivity of at least 115 M Ω·m after the fluid has been aged according to JIS K2514-1 at 150°C.