SUMMARY AND TERMS

In one aspect, the present disclosure relates to use of a lubricating composition for providing a balance between catalytic converter life, efficiency and wear in an internal combustion engine of a hybrid vehicle, wherein the internal combustion engine of the hybrid vehicle is operated at a temperature of 100°C or less, comprising lubricating the internal combustion engine of the hybrid vehicle with a lubricating oil composition comprising:

greater than 50 wt.% of a base oil of lubricating viscosity; and

an amount of one or more zinc dialkyl dithiophosphate compound(s) sufficient to provide:

from 100 ppmw phosphorus to 1000 ppmw phosphorus, based on a total weight of the lubricating oil composition; and

from 10 ppmw zinc to 1200 ppmw zinc, based on the total weight of the lubricating oil composition,

wherein the one or more zinc dialkyl dithiophosphate compounds are derived from 100 mole% of one or more primary alkyl alcohol(s).

In a first example, the present disclosure relates to a method for improving phosphorus retention in an internal combustion engine of a hybrid vehicle. The method includes lubricating the internal combustion engine of the hybrid vehicle with a lubricating oil composition including:

greater than 50 wt.% of a base oil of lubricating viscosity; and

an amount of one or more zinc dialkyl dithiophosphate compound(s) sufficient to provide:

from about 100 ppmw phosphorus to about 1000 ppmw phosphorus, based on a total weight of the lubricating oil composition; and

from about 10 ppmw zinc to about 1200 ppmw zinc, based on the total weight of the lubricating oil composition,

wherein the one or more zinc dialkyl dithiophosphate compounds are derived from one or more primary alkyl alcohol(s), one or more secondary alkyl alcohol(s), or combinations thereof.

In the foregoing method, the phosphorus retention may be sufficient to reduce catalyst poisoning relative to a same lubricating oil composition without the one or more zinc dialkyl dithiophosphate compounds.

In each of the foregoing methods, the internal combustion engine of the hybrid vehicle may be operated at a temperature of 100ºC or less, or from about 70ºC to about 100ºC.

In each of the foregoing methods, the one or more zinc dialkyl dithiophosphate compound(s) may be derived from one or more primary alkyl alcohol(s) each having an alkyl group with 3 to 8 carbon atoms.

In each of the foregoing methods, the alkyl group of the one or more primary alkyl alcohol(s) may have branching at the beta carbon relative to the hydroxyl group.

In each of the foregoing methods, the one or more zinc dialkyl dithiophosphate compound(s) is derived from one or more primary alkyl alcohol selected from the group consisting of n-propyl alcohol, isopropyl alcohol, isobutyl alcohol, n-butyl alcohol, 2-butanol, n-penyl alcohol, hexanol, methyl isobutyl carbinol, isohexanol, n-heptanol, isoheptanol, octanol, amyl alcohol, and 2-ethylhexanol.

In each of the foregoing methods, the one or more zinc dialkyl dithiophosphate compound(s) may be derived from two or more primary alkyl alcohols.

In each of the foregoing methods, the one or more zinc dialkyl dithiophosphate compound(s) may be derived the one or more secondary alkyl alcohol(s) having an alkyl group with 3 to 8 carbon atoms.

In each of the foregoing methods, the one or more zinc dialkyl dithiophosphate compound(s) may be derived from a secondary alkyl alcohol selected from the group consisting of isopropyl alcohol, amyl alcohol, and methyl isobutyl carbinol.

In each of the foregoing methods, the one or more zinc dialkyl dithiophosphate compound(s) may be derived from two or more secondary alkyl alcohols.

In each of the foregoing methods, the one or more zinc dialkyl dithiophosphate compound(s) may be derived from a molar ratio of the one or more primary alkyl alcohol(s) to the one or more secondary alkyl alcohol(s) of from 100:20 to 50:50.

In each of the foregoing methods, the one or more zinc dialkyl dithiophosphate compound(s) may be a zinc to phosphorus weight ratio of from 1.08 to 1.3.

In each of the foregoing methods, wherein the one or more zinc dialkyl dithiophosphate compound(s) may comprise an average number of total carbon atoms per mole of phosphorus of from about 5 to about 30, or from about 8 to about 20.

In each of the foregoing methods, the lubricating oil composition may further comprise a calcium-sulfonate detergent. The calcium-sulfonate detergent may comprise an overbased calcium-sulfonate detergent and/or a low-based/neutral calcium-sulfonate detergent. The lubricating oil composition may comprise from about 500 ppmw to about 2000 ppmw calcium from the calcium-sulfonate detergent, based on a total weight of the lubricating oil composition.

In each of the foregoing methods, the lubricating oil composition may comprise a borated succinimide dispersant.

In each of the foregoing methods, the lubricating oil composition may further comprise a succinimide dispersant. In some examples, the succinimide dispersant is a borated succinimide. Preferably, the borated succinimide is present in an amount of from about 5 ppmw to about 300 ppmw.

In each of the foregoing methods, the lubricating oil composition may further comprise one or more components selected from the group consisting of organic friction modifier(s), molybdenum-containing compound(s), calcium sulfonate detergent(s), antioxidant(s), antifoam agent(s), pour point depressant(s), and viscosity index improver(s).

In one aspect, the present disclosure relates to use of a lubricating oil composition for reducing wear in an internal combustion engine of a hybrid vehicle, wherein the internal combustion engine of the hybrid vehicle is operated at a temperature of 100°C or less, comprising lubricating the internal combustion engine of the hybrid vehicle with a lubricating oil composition comprising:

greater than 50 wt.% of a base oil of lubricating viscosity; and

an amount of one or more zinc dialkyl dithiophosphate compound(s) sufficient to provide: from 100 ppmw phosphorus to 1000 ppmw phosphorus, based on a total weight of the lubricating oil composition, and

from 10 ppmw zinc to 1200 ppmw zinc, based on the total weight of the lubricating oil composition;

wherein the one or more zinc dialkyl dithiophosphate compounds are derived from 100 mole % of one or more primary alkyl alcohol(s); and

the one or more zinc dialkyl dithiophosphate compound(s) has a zinc to phosphorus weight ratio of from 1.20 and greater.

In a second example, the disclosure relates to a method for reducing wear in an internal combustion engine of a hybrid vehicle comprising lubricating the internal combustion engine of the hybrid vehicle with a lubricating oil composition comprising:

greater than 50 wt.% of a base oil of lubricating viscosity; and

an amount of one or more zinc dialkyl dithiophosphate compound(s) sufficient to provide:

In each of the foregoing second examples, the lubricating oil composition may further comprise a succinimide dispersant. In some examples, the succinimide dispersant is a borated succinimide dispersant. In some examples, the lubricating oil composition comprises about 5 ppmw of boron to about 300 ppmw of boron from the borated succinimide dispersant.

In each of the foregoing second examples, the lubricating oil composition may further comprise one or more components selected from the group consisting of organic friction modifier(s), molybdenum-containing compound(s) calcium sulfonate detergent(s), antioxidant(s), antifoam agent(s), pour point depressant(s), and viscosity index improver(s).

In a third example, the disclosure relates to a lubricating oil composition for use in an internal combustion engine of a hybrid vehicle, comprising:

greater than 50 wt.% of a base oil of lubricating viscosity; and

an amount of one or more zinc dialkyl dithiophosphate compound(s) sufficient to provide:

from about 100 ppmw phosphorus to about 1000 ppmw phosphorus, based on a total weight of the lubricating oil composition, and

from about 10 ppmw zinc to about 1200 ppmw zinc, based on the total weight of the lubricating oil composition.

In another aspect, the present disclosure relates to a lubricating oil composition for use in an internal combustion engine of a hybrid vehicle, and the internal combustion engine of the hybrid vehicle is operated at a temperature of 100°C or less, comprising:

greater than 50 wt.% of a base oil of lubricating viscosity; and

an amount of one or more zinc dialkyl dithiophosphate compound(s) sufficient to provide:

from 100 ppmw phosphorus to 1000 ppmw phosphorus, based on a total weight of the lubricating oil composition, and

from 10 ppmw zinc to 1200 ppmw zinc, based on the total weight of the lubricating oil composition,

wherein the one or more zinc dialkyl dithiophosphate compounds are derived from 100 mole% of one or more primary alkyl alcohol(s) and; wherein the one or more zinc dialkyl dithiophosphate compound(s) has a zinc to phosphorous weight ratio of 1.20 or greater.

In the third example, the one or more zinc dialkyl dithiophosphate compounds may be derived from one or more primary alkyl alcohol(s), one or more secondary alkyl alcohol(s), or combinations thereof and wherein the one or more zinc dialkyl dithiophosphate compound(s) is derived from a molar ratio of the one or more primary alkyl alcohol(s) to the one or more secondary alkyl alcohol(s) of form 100:20 to 50:50. The one or more zinc dialkyl dithiophosphate compound(s) may have a zinc to phosphorus weight ratio of from 1.08 to 1.3.

In each of the foregoing third examples, the lubricating oil composition may be configured for use in an internal combustion engine of the hybrid vehicle that is operated at a temperature of 100ºC or less.

In each of the foregoing third examples, the lubricating oil composition may further comprise a calcium-sulfonate detergent. The calcium-sulfonate detergent may comprise an overbased calcium-sulfonate detergent and/or a low-based/neutral calcium-sulfonate detergent. The lubricating oil composition may comprise from about 500 ppmw to about 2000 ppmw calcium from the calcium-sulfonate detergent, based on a total weight of the lubricating oil composition.

In each of the foregoing third examples, the lubricating oil composition may further comprise a succinimide dispersant. In some examples, the succinimide dispersant is a borated

What is Claimed is:

1. Use of a lubricating composition for providing a balance between catalytic converter life, efficiency and wear in an internal combustion engine of a hybrid vehicle, wherein the internal combustion engine of the hybrid vehicle is operated at a temperature of 100°C or less, comprising lubricating the internal combustion engine of the hybrid vehicle with a lubricating oil composition comprising:

greater than 50 wt.% of a base oil of lubricating viscosity; and

an amount of one or more zinc dialkyl dithiophosphate compound(s) sufficient to provide:

from 100 ppmw phosphorus to 1000 ppmw phosphorus, based on a total weight of the lubricating oil composition; and

from 10 ppmw zinc to 1200 ppmw zinc, based on the total weight of the lubricating oil composition,

wherein the one or more zinc dialkyl dithiophosphate compounds are derived from 100 mole% of one or more primary alkyl alcohol(s).

2. The use of claim 1, wherein the one or more zinc dialkyl dithiophosphate compound(s) is derived from one or more primary alkyl alcohol(s) each having an alkyl group with 3 to 8 carbon atoms.

3. The use of any one of claims 1 - 2, wherein the one or more zinc dialkyl dithiophosphate compound(s) has a zinc to phosphorus weight ratio of from 1.08 to 1.3.

4. The use of any one of claims 1 - 3, wherein the one or more zinc dialkyl dithiophosphate compound(s) comprises an average number of total carbon atoms per mole of phosphorus of from 5 to 30.

5. The use of any one of claims 1 - 4, wherein the lubricating oil composition comprises a borated succinimide dispersant.

6. Use of a lubricating oil composition for reducing wear in an internal combustion engine of a hybrid vehicle, wherein the internal combustion engine of the hybrid vehicle is operated at a temperature of 100°C or less, comprising lubricating the internal combustion engine of the hybrid vehicle with a lubricating oil composition comprising:

greater than 50 wt.% of a base oil of lubricating viscosity; and

an amount of one or more zinc dialkyl dithiophosphate compound(s) sufficient to provide: from 100 ppmw phosphorus to 1000 ppmw phosphorus, based on a total weight of the lubricating oil composition, and

from 10 ppmw zinc to 1200 ppmw zinc, based on the total weight of the lubricating oil composition;

wherein the one or more zinc dialkyl dithiophosphate compounds are derived from 100 mole % of one or more primary alkyl alcohol(s); and

the one or more zinc dialkyl dithiophosphate compound(s) has a zinc to phosphorus weight ratio of from 1.20 and greater.

7. The use of claim 6, wherein the one or more zinc dialkyl dithiophosphate compound(s) is derived from the one or more primary alkyl alcohol(s) having an alkyl group with 3 to 9 carbon atoms.

8. The use of any one of claims 6 - 7, wherein the one or more zinc dialkyl dithiophosphate compound(s) comprises an average number of total carbon atoms per mole of phosphorus of from 8 to 30, or from 12 to 20.

9. The use of any one of claims 6 - 8, wherein the alkyl group of the one or more primary alkyl alcohol(s) has branching at the beta carbon relative to the hydroxyl group.

10. The use of any one of claims 6 - 9, wherein the one or more zinc dialkyl dithiophosphate compound(s) is derived from the one or more primary alkyl alcohol(s) selected from the group consisting of n-propyl alcohol, isopropyl alcohol, n-butyl alcohol, 2-butanol, n-penyl alcohol, hexanol, methyl isobutyl carbinol, isohexanol, n-heptanol, isoheptanol, octanol, isobutyl alcohol, amyl alcohol, and 2-ethylhexanol.

11. The use of any one of claims 6 - 10, wherein the one or more zinc dialkyl dithiophosphate compound(s) is derived from two or more primary alkyl alcohols.

12. The use of any one of claims 6 - 11, wherein the one or more zinc dialkyl dithiophosphate compound(s) is overbased with zinc oxide.

13. The use of any one of claims 1 - 12, wherein the lubricating oil composition further comprises a calcium-sulfonate detergent.

14. The use of claim 13, wherein the lubricating oil composition comprises from 500 ppmw to 2000 ppmw calcium from the calcium-sulfonate detergent, based on a total weight of the lubricating oil composition.

15. The use of any one of claims 1 - 14, wherein the lubricating oil composition comprises a succinimide dispersant.

16. The use of any one of claims 1 - 15, wherein the lubricating oil composition comprises a borated succinimide dispersant.

17. The use of any one of claims 1 - 16, wherein the lubricating oil composition further comprises an antioxidant.

18. The use of any one of claims 1 - 17, wherein the lubricating oil composition further comprises one or more components selected from the group consisting of organic friction modifier(s), molybdenum-containing compound(s), antioxidant(s), antifoam agent(s), pour point depressant(s), and viscosity index improver(s).

19. A lubricating oil composition for use in an internal combustion engine of a hybrid vehicle, and the internal combustion engine of the hybrid vehicle is operated at a temperature of 100°C or less, comprising:

greater than 50 wt.% of a base oil of lubricating viscosity; and

an amount of one or more zinc dialkyl dithiophosphate compound(s) sufficient to provide: from 100 ppmw phosphorus to 1000 ppmw phosphorus, based on a total weight of the lubricating oil composition, and

from 10 ppmw zinc to 1200 ppmw zinc, based on the total weight of the lubricating oil composition,

wherein the one or more zinc dialkyl dithiophosphate compounds are derived from 100 mole% of one or more primary alkyl alcohol(s) and; wherein the one or more zinc dialkyl dithiophosphate compound(s) has a zinc to phosphorous weight ratio of 1.20 or greater.

20. The lubricating oil composition of claim 19, wherein the one or more zinc dialkyl dithiophosphate compound(s) has a zinc to phosphorus weight ratio of from 1.20 to 1.3.

21. The lubricating oil composition of any one of claims 19 - 20, wherein the lubricating oil composition further comprises a calcium-sulfonate detergent.

22. The lubricating oil composition of claim 21, wherein the calcium-sulfonate detergent comprises an overbased calcium-sulfonate detergent and/or a low-based/neutral calcium-sulfonate detergent.

23. The lubricating oil composition of any one of claims 21 - 22, wherein the lubricating oil composition comprises from 500 ppmw to 2000 ppmw calcium from the calcium-sulfonate detergent, based on a total weight of the lubricating oil composition.

24. The lubricating oil composition of any one of claims 19 - 23, wherein the lubricating oil composition further comprises a succinimide dispersant.

25. The lubricating oil composition of any one of claims 19 - 24, wherein the lubricating oil composition comprises a borated succinimide dispersant.

26. The lubricating oil composition of claim 25, wherein the lubricating oil composition comprises 5 ppmw of boron to 300 ppmw of boron from the borated succinimide dispersant.

27. The lubricating oil composition of any one of claims 19 - 25, wherein the lubricating oil composition further comprises one or more components selected from the group consisting of organic friction modifier(s), molybdenum-containing compound(s) calcium sulfonate detergent(s), antioxidant(s), antifoam agent(s), pour point depressant(s), and viscosity index improver(s).

LUBRICATING COMPOSITIONS FOR A HYBRID ENGINE

ABSTRACT

The present disclosure relates to methods for improving phosphorus retention and improving antiwear performance in an internal combustion engine of a hybrid vehicle, comprising lubricating the internal combustion engine of the hybrid vehicle with a lubricating oil composition comprising: greater than 50 wt.% of a base oil of lubricating viscosity; and an amount of one or more zinc dialkyl dithiophosphate compound(s) sufficient to provide: from about 100 ppmw phosphorus to about 1000 ppmw phosphorus, based on a total weight of the lubricating oil composition; and from about 10 ppmw zinc to about 1200 ppmw zinc, based on the total weight of the lubricating oil composition.

[No Available Figure]