LUBRICANTS FOR USE IN BOOSTED ENGINES

TECHNICAL FIELD

[0001] The disclosure relates to lubricant compositions having improved resistance to the formation of engine deposits, including turbocharger deposits, when used in a boosted internal combustion engine.

BACKGROUND

[0002] Turbocharged or supercharged engines (i.e. boosted or forced induction internal combustion engines) experience very high operating temperatures. The lubricants used in these engines are exposed to extreme conditions when the engine is stopped, and the lubricant sits in a hot turbocharger as it cools. A lubricant in this environment is prone to the formation of hard deposits in the turbocharger. This phenomenon causes a significant deterioration of turbocharger efficiency which has the potential to cause poor performance and/or severe damage to the engine.

[0003] Several published studies have demonstrated that turbocharger use, engine design, engine coatings, piston shape, fuel choice, and/or engine oil additives may contribute to the formation of these deposits in turbocharged engines. Accordingly, there is a need for engine oil additive components and/or combinations that are effective to reduce or prevent the formation of deposits in turbocharged gasoline engines.

[0004] Recent specifications such as the 2015 version of the General Motors dexos1® specification, require passage of a Turbocharger Coking Test. One parameter to determine a passing result in the General Motors dexos1® Turbocharger Coking Test is maintaining a percent increase to less than a 13% increase in the Turbo Coolant Outside (TCO) Temperature from the 100 cycle TCO Temperature to the 1800 cycle TCO temperature.

[0005] There is a need to improve on a simple pass of the 2015 version of the General Motors dexos1® Turbocharger Coking Test to provide lubricating oil compositions that can score pass ratings of only a 9.0% increase in the Turbo Coolant Outside (TCO) Temperature from the 100 cycle TCO Temperature to the 1800 cycle TCO temperature. “TCO Temperature Increase” as used herein refers to the percent increase in the TCO Temperature from the 100 cycle TCO Temperature to the 1800 cycle TCO temperature as defined by the formula:

$$\frac{\text{(1800 cycle TCO Temperature - 100 cycle TCO temperature)}}{\text{100 cycle TCO Temperature.}}$$

SUMMARY AND TERMS

[0005a] In one aspect, the present disclosure refers to a lubricating oil composition comprising:

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

at least one detergent selected from one or more overbased calcium-containing detergents having a total base number of greater than 225 mg KOH/g, as measured by the method of ASTM D-2896,

a boron-containing dispersant,

an oil-soluble molybdenum compound, and

wherein the lubricating oil composition comprises calcium, nitrogen, molybdenum and boron,

a weight ratio of Ca:N in the lubricating oil composition is greater than 1.4 to less than 3.0, a weight ratio of Ca:Mo in the lubricating oil composition is greater than 6.7 to less than 56.3, and a weight ratio of Ca:B in the lubricating oil composition is greater than 5.0 to less than 9.8,

the lubricating oil composition does not contain added magnesium from a magnesium-containing detergent, and

the lubricating oil composition is effective to ensure a TCO Temperature Increase of less than 9.0% as measured using the 2015 version of the General Motors dexos1® Turbocharger Coking Test.

[0005b] In another aspect, the present disclosure refers to a method for reducing or preventing formation of deposits in a boosted internal combustion engine comprising steps of:

lubricating a boosted internal combustion engine with a lubricating oil composition comprising

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

at least one detergent selected from one or more overbased calcium-containing detergents having a total base number of greater than 225 mg KOH/g, as measured by the method of ASTM D-2896,

a boron-containing dispersant,

an oil-soluble molybdenum compound, and

wherein the lubricating oil composition comprises calcium, nitrogen, molybdenum and boron,

a weight ratio of Ca:N in the lubricating oil composition is greater than 1.4 to less than 3.0, a weight ratio of Ca:Mo in the lubricating oil composition is greater than 6.7 to less than 56.3, and a weight ratio of Ca:B in the lubricating oil composition is greater than 5.0 to less than 10,

the lubricating oil composition does not contain added magnesium from a magnesium-containing detergent, and

the lubricating oil composition is effective to ensure a TCO Temperature Increase of less than 9.0% as measured using the 2015 version of the General Motors dexos1® Turbocharger Coking Test, and

operating the engine lubricated with the lubricating oil composition.

[0006] The present disclosure relates to a lubricating oil composition and method of operating a boosted internal combustion engine. The lubricating oil composition includes greater than 50 wt.% of a base oil of lubricating viscosity, and calcium, nitrogen, molybdenum and boron. The weight ratio of Ca:N (ppm/ppm) in the lubricating oil composition is greater than 1.3 to less than 3.0, the weight ratio of Ca:Mo (ppm/ppm) in the lubricating oil composition is greater than 6.7 to less than 56.3, and the weight ratio of Ca:B (ppm/ppm) in the lubricating oil composition is greater than 5.0 to less than 9.8. The lubricating oil composition does not contain added magnesium from a magnesium-containing detergent. Moreover, the lubricating oil composition is resistant to deposit formation in the boosted internal combustion engine, as shown by its ability to ensure a TCO Temperature Increase of less than 9.0% as measured using the 2015 version of the General Motors dexos1® Turbocharger Coking Test (TC Test).

[0007] In another embodiment, the disclosure provides a method for reducing or preventing the formation of deposits in a boosted internal combustion engine. The method includes a step of lubricating a boosted internal combustion engine with a lubricating oil composition comprising greater than 50 wt.% of a base oil of lubricating viscosity, and calcium, nitrogen, molybdenum and boron, and operating the engine lubricated with the lubricating oil composition. The weight ratio of Ca:N (ppm/ppm) in the lubricating oil composition is greater than 1.3 to less than 3.0, the weight ratio of Ca:Mo (ppm/ppm) in the lubricating oil composition is greater than 6.7 to less than 56.3, and the weight ratio of Ca:B (ppm/ppm) in the lubricating oil composition is greater than 5.0 to less than 9.8. The lubricating oil composition does not contain added magnesium from a magnesium-containing detergent. By lubricating a boosted internal combustion engine with this lubricating oil composition there will be improved resistance to deposit formation in the boosted internal combustion engine, as shown by its ability to ensure a TCO Temperature Increase of less than 9.0% as measured using the 2015 version of the General Motors dexos1® Turbocharger Coking Test.

[0008] In any of the foregoing embodiments, the lubricating oil composition may comprise at least one detergent selected from one or more overbased calcium-containing detergents having a total base number (TBN) of greater than 225 mg KOH/g, measured by the method of ASTM D-2896, and optionally one or more low-based/neutral calcium-containing

What is claimed is:

1. A lubricating oil composition comprising:

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

at least one detergent selected from one or more overbased calcium-containing detergents having a total base number of greater than 225 mg KOH/g, as measured by the method of ASTM D-2896,

a boron-containing dispersant,

an oil-soluble molybdenum compound, and

wherein the lubricating oil composition comprises calcium, nitrogen, molybdenum and boron,

a weight ratio of Ca:N in the lubricating oil composition is greater than 1.4 to less than 3.0, a weight ratio of Ca:Mo in the lubricating oil composition is greater than 6.7 to less than 56.3, and a weight ratio of Ca:B in the lubricating oil composition is greater than 5.0 to less than 9.8,

the lubricating oil composition does not contain added magnesium from a magnesium-containing detergent, and

the lubricating oil composition is effective to ensure a TCO Temperature Increase of less than 9.0% as measured using the 2015 version of the General Motors dexos1® Turbocharger Coking Test.

2. The lubricating oil composition of claim 1, wherein the at least one detergent comprises one or more low-based/neutral calcium-containing detergents having a total base number of up to 175 mg KOH/g, measured by the method of ASTM D-2896.

3. The lubricating oil composition of claim 2, wherein the one or more overbased calcium-containing detergents is selected from an overbased calcium sulfonate detergent, an overbased calcium phenate detergent, an overbased calcium salicylate detergent and mixtures thereof.

4. The lubricating oil composition of claim 2, wherein the one or more overbased calcium-containing detergents provides from 900 to 3000 ppm by weight calcium to the lubricating oil composition, based on a total weight of the lubricating oil composition.

5. The lubricating oil composition of claim 1, wherein the total base number of the lubricating oil composition is at least 6.0 mg KOH/g of the lubricating oil composition as measured by the method of ASTM D-2896.

6. The lubricating oil composition according to claim 1, wherein the total amount of magnesium in the lubricating oil composition is less than 50 ppm, based on a total weight of the lubricating oil composition.

7. The lubricating oil composition according to claim 1, wherein the lubricating oil composition comprises a boron-containing dispersant.

8 The lubricating oil composition according to claim 1, wherein the lubricating oil composition comprises an oil-soluble molybdenum compound.

9. The lubricating oil composition according to claim 1, wherein the nitrogen is present in the lubricating oil composition in an amount of 500 ppm to 2500 ppm, based on a total weight of the lubricating oil composition.

10. The lubricating oil composition of claim 1, further comprising one or more components selected from the group consisting of friction modifiers, antiwear agents, dispersants, antioxidants, and viscosity index improvers.

11. The lubricating oil composition of claim 1, wherein the greater than 50 wt.% of base oil is selected from the group consisting of Group II, Group III, Group IV, Group V base oils, and a combination of two or more of the foregoing, and wherein the greater than 50 wt.% of base oil is other than diluent oils that arise from provision of additive components or viscosity index improvers in the composition.

12. The lubricating oil composition of claim 1, wherein the weight ratio of Ca:N in the lubricating oil composition is from 1.4 to 2.8.

13. The lubricating oil composition of claim 1, wherein the weight ratio of Ca:Mo in the lubricating oil composition is from 6.8 to 45.

14. The lubricating oil composition of claim 1, wherein the weight ratio of Ca:B in the lubricating oil composition is from greater than 5.1 to 9.7.

15. The lubricating oil composition of claim 1, wherein the lubricating oil composition is

effective to ensure a TCO Temperature Increase of less than 8.0% as measured using the 2015 version of the General Motors dexos1® Turbocharger Coking Test.

16. A method for reducing or preventing formation of deposits in a boosted internal combustion engine comprising steps of:

lubricating a boosted internal combustion engine with a lubricating oil composition comprising

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

at least one detergent selected from one or more overbased calcium-containing detergents having a total base number of greater than 225 mg KOH/g, as measured by the method of ASTM D-2896,

a boron-containing dispersant,

an oil-soluble molybdenum compound, and

wherein the lubricating oil composition comprises calcium, nitrogen, molybdenum and boron,

a weight ratio of Ca:N in the lubricating oil composition is greater than 1.4 to less than 3.0, a weight ratio of Ca:Mo in the lubricating oil composition is greater than 6.7 to less than 56.3, and a weight ratio of Ca:B in the lubricating oil composition is greater than 5.0 to less than 10,

the lubricating oil composition does not contain added magnesium from a magnesium-containing detergent, and

the lubricating oil composition is effective to ensure a TCO Temperature Increase of less than 9.0% as measured using the 2015 version of the General Motors dexos1® Turbocharger Coking Test, and

operating the engine lubricated with the lubricating oil composition.

17. The method of claim 16, wherein the at least one detergent comprises one or more low-based/neutral calcium-containing detergents having a total base number of up to 175 mg KOH/g, measured by the method of ASTM D-2896.

18. The method of claim 17, wherein the one or more overbased calcium-containing detergents provides from 900 to 3000 ppm by weight calcium to the lubricating oil composition, based on a total weight of the lubricating oil composition.

19. The method of claim 16, wherein the nitrogen is present in the lubricating oil composition in an amount of from 500 ppm to 2500 ppm, based on a total weight of the lubricating oil composition.

20. The method of claim 16, wherein the lubricating step lubricates a combustion chamber or cylinder walls of a spark-ignited direct injection engine or spark-ignited port fuel injected internal combustion engine provided with a turbocharger or a supercharger.