

IMPROVING CORROSION, RUST, AND EMULSION RETENTION IN HYDROGEN ENGINES

CROSS-REFERENCE TO RELATED APPLICATIONS

[001] This application claims the benefit of U.S. Provisional Application No. 63/583,043, filed September 15, 2023, which is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[002] This disclosure relates to lubricating oil compositions. More specifically, this disclosure relates to lubricating oil formulations designed to improve corrosion, rust, and/or emulsion retention performance in hydrogen fuel or methanol fuel engines.

BACKGROUND

[003] As new engine technologies gain wider acceptance, new lubricants are needed to optimize their performance. For example, hydrogen fuel or methanol fuel engines produce more water compared to conventional internal combustion engines and, as a result, are much more susceptible to corrosion. Lubricant formulators may need to address rust and/or emulsion retention concerns when formulating for hydrogen fuel or methanol fuel engines. Consequently, there is a need for new lubricating oils that are designed specifically for hydrogen fuel engines.

SUMMARY

[004] In one aspect, there is provided a method of reducing corrosion and/or rust in hydrogen fuel or methanol fuel engine, the method comprising: lubricating the hydrogen fuel or methanol fuel engine with a lubricating oil composition comprising: major amount of an oil of lubricating viscosity; and an aromatic triazole compound.

[005] In another aspect, there is provided a method for maintaining emulsion stability in a hydrogen fuel or methanol fuel engine, the method comprising: lubricating the hydrogen fuel or methanol fuel engine with a lubricating oil composition comprising: major amount of an oil of lubricating viscosity; and an aromatic triazole compound.

[006] In yet another aspect, there is provided a use of a lubricating oil composition to inhibit corrosion in hydrogen fuel or methanol fuel engine, wherein the lubricating oil

composition comprises: major amount of an oil of lubricating viscosity; and an aromatic triazole compound.

DETAILED DESCRIPTION

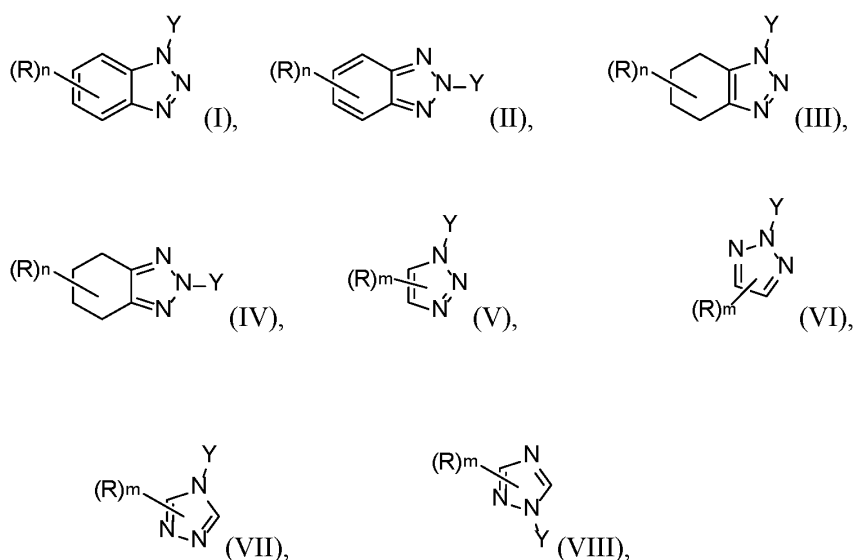
[007] It is understood that when combinations, subsets, groups, etc. of elements are disclosed (e.g., combinations of components in a composition, or combinations of steps in a method), that while specific reference of each of the various individual and collective combinations and permutations of these elements may not be explicitly disclosed, each is specifically contemplated and described herein.

[008] The present disclosure relates to lubricating oil compositions for use in hydrogen fuel engines. The lubricating oil compositions are formulated to enhance or improve corrosion, rust, and/or emulsion retention performance. The lubricating oil composition of this disclosure includes a major amount of base oil and a triazole compound described herein.

Triazole Compound

[009] The lubricating oil composition of the present disclosure includes a triazole compound which imparts one or more performance benefits to the lubricating oil composition.

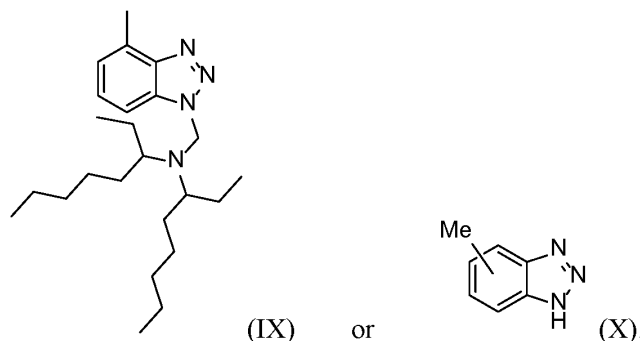
[010] The triazole of the present disclosure may be an aromatic triazole with one of the following structures:



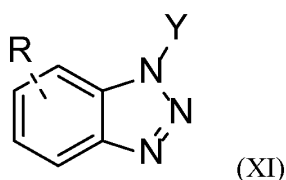
or a combination thereof; where, n is an integer from 0 to 4, m is 0, 1, or 2, R is a C1-C24 hydrocarbyl group and Y is -R¹ or -(R²)_p-NR³R³ where -R¹ is a C1-C24 hydrocarbyl group, -

R^2 - is a C1-C24 hydrocarbylene group, p is 0 or 1, and each $-R^3$ is independently hydrogen or C1-C24 hydrocarbyl group.

[011] In an example, the triazole may have the following structure (IX) or (X):



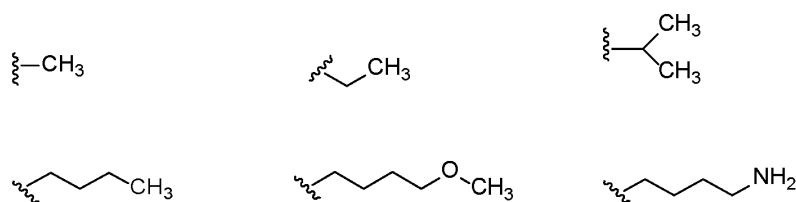
[012] In some embodiments, the triazole compound is given by the following generalized structure (Structure XI):

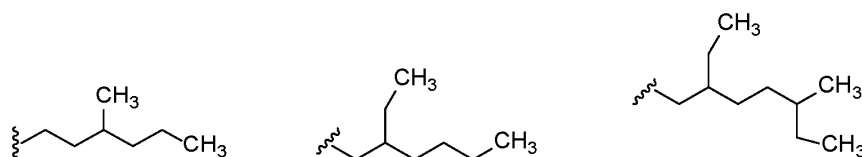


wherein R is a C1-C20 hydrocarbyl group and Y is hydrogen, R^1 , or $(R^2)_p-NR^3R^4$, wherein R^1 is a C1-C20 hydrocarbyl group, R^2 is a C1-C20 hydrocarbylene group, R^3 and R^4 are independently hydrogen or C1-C20 hydrocarbyl group, and p is 0 or 1; and wherein the triazole compound has a molecular weight of about 70 to about 1000 g/mol.

[013] The term “hydrocarbyl” refers to a moiety that includes both carbon and hydrogen atoms (“hydrocarbon”). In some embodiments, hydrocarbyl may refer to hydrocarbon comprising heteroatoms (e.g., sulfur, nitrogen, oxygen, etc.). Hydrocarbyl may refer to saturated or unsaturated moieties, aliphatic or aromatic moieties, cyclic or acyclic, branched or unbranched moieties.

[014] Examples of hydrocarbyl groups include the following:





[015] The term “hydrocarbylene” generally refers to a divalent radical formed by removing two hydrogens from a hydrocarbon. The term may also refer to unsaturated hydrocarbons. Examples include methylene, ethylene, propylene, and the like.

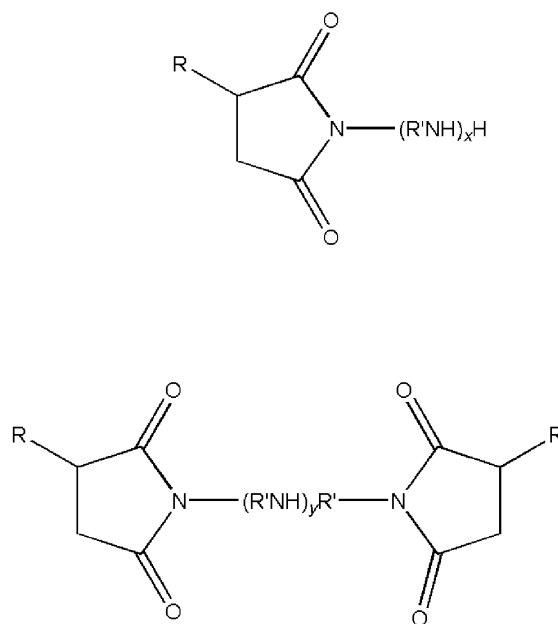
[016] The amount of triazole compound is from about 0.01 wt.% to about 10 wt.% based on the total lubricating oil composition such as from about 0.01 wt.% to about 9 wt.%, about 0.01 wt.% to about 8 wt.%, about 0.01 wt.% to about 7 wt.%, about 0.01 wt.% to about 6 wt.%, about 0.01 wt.% to about 5 wt.%, about 0.01 wt.% to about 4 wt.%, about 0.01 wt.% to about 3 wt.%, about 0.01 wt.% to about 2 wt.%, about 0.01 wt.% to about 1 wt.%, about 0.1 wt.% to about 10 wt.%, about 0.1 wt.% to about 9 wt.%, about 0.1 wt.% to about 8 wt.%, about 0.1 wt.% to about 7 wt.%, about 0.1 wt.% to about 6 wt.%, about 0.1 wt.% to about 5 wt.%, about 0.1 wt.% to about 4 wt.%, about 0.1 wt.% to about 3 wt.%, about 0.1 wt.% to about 2 wt.%, about 0.1 wt.% to about 1 wt.%, about 0.5 wt.% to about 10 wt.%, about 0.5 wt.% to about 9 wt.%, about 0.5 wt.% to about 8 wt.%, about 0.5 wt.% to about 7 wt.%, about 0.5 wt.% to about 6 wt.%, about 0.5 wt.% to about 5 wt.%, about 0.5 wt.% to about 4 wt.%, about 0.5 wt.% to about 3 wt.%, about 0.5 wt.% to about 2 wt.%, about 0.5 wt.% to about 1 wt.%, about 1 wt.% to about 10 wt.%, about 1 wt.% to about 9 wt.%, about 1 wt.% to about 8 wt.%, about 1 wt.% to about 7 wt.%, about 1 wt.% to about 6 wt.%, about 1 wt.% to about 5 wt.%, about 1 wt.% to about 4 wt.%, about 1 wt.% to about 3 wt.%, about 1 wt.% to about 2 wt.%, about 2 wt.% to about 10 wt.%, about 2 wt. % to about 9 wt.%, about 2 wt.% to about 8 wt.%, about 2 wt.% to about 7 wt.%, about 2 wt.% to about 6 wt.%, about 2 wt.% to about 5 wt.%, about 2 wt.% to about 4 wt.%, about 2 wt.% to about 3 wt.%, about 3 wt.% to about 10 wt.%, about 3 wt.% to about 9 wt.%, about 3 wt.% to about 8 wt.%, about 3 wt.% to about 7 wt.%, about 3 wt.% to about 6 wt.%, about 3 wt.% to about 5 wt.%, about 3 wt.% to about 4 wt.%, about 4 wt.% to about 10 wt.%, about 4 wt.% to about 9 wt.%, about 4 wt.% to about 8 wt.%, about 4 wt.% to about 7 wt.%, about 4 wt.% to about 6 wt.%, about 4 wt.% to about 5 wt.%, about 5 wt.% to about 10 wt.%, about 5 wt.% to about 9 wt.%, about 5 wt.% to about 8 wt.%, about 5 wt.% to

about 7 wt.%, about 5 wt.% to about 6 wt.%, about 6 wt.% to about 10 wt.%, about 6 wt.% to about 9 wt.%, about 6 wt.% to about 8 wt.%, about 6 wt.% to about 7 wt.%, about 7 wt.% to about 10 wt.%, about 7 wt.% to about 9 wt.%, about 7 wt.% to about 8 wt.%, about 8 wt.% to about 10 wt.%, about 8 wt.% to about 9 wt.%, and about 9 wt.% to about 10 wt.%.

[017] In addition to the triazole compound, the lubricating oil composition may include additional optional additives. These optional additives are generally known in the art and include, but are not limited to, the following.

Molybdenum succinimide

[018] In one embodiment, the molybdenum amine is a molybdenum-succinimide complex. Suitable molybdenum-succinimide complexes are described, for example, in U.S. Patent No. 8,076,275. These complexes are prepared by a process comprising reacting an acidic molybdenum compound with an alkyl or alkenyl succinimide of a polyamine below:



wherein R is a C_{24} to C_{350} (e.g., C_{70} to C_{128}) alkyl or alkenyl group; R' is a straight or branched-chain alkylene group having 2 to 3 carbon atoms; x is 1 to 11; and y is 1 to 11.

[019] The molybdenum compounds used to prepare the molybdenum-succinimide complex are acidic molybdenum compounds or salts of acidic molybdenum compounds. By “acidic” is meant that the molybdenum compounds will react with a basic nitrogen compound as measured by ASTM D664 or D2896. Generally, the acidic molybdenum compounds are

hexavalent. Representative examples of suitable molybdenum compounds include molybdenum trioxide, molybdic acid, ammonium molybdate, sodium molybdate, potassium molybdate and other alkaline metal molybdates and other molybdenum salts such as hydrogen salts, (e.g., hydrogen sodium molybdate), MoOCl_4 , MoO_2Br_2 , $\text{Mo}_2\text{O}_3\text{Cl}_6$, and the like.

[020] The succinimides that can be used to prepare the molybdenum-succinimide complex are disclosed in numerous references and are well known in the art. Certain fundamental types of succinimides and the related materials encompassed by the term of art “succinimide” are taught in U.S. Patent Nos. 3,172,892; 3,219,666; and 3,272,746. The term “succinimide” is understood in the art to include many of the amide, imide, and amidine species which may also be formed. The predominant product however is a succinimide and this term has been generally accepted as meaning the product of a reaction of an alkyl or alkenyl substituted succinic acid or anhydride with a nitrogen-containing compound. Preferred succinimides are those prepared by reacting a polyisobutenyl succinic anhydride of about 70 to 128 carbon atoms with a polyamine.

[021] Preferred polyamines may have 2 to 60 carbon atoms and from 2 to 12 nitrogen atoms per molecule. Particularly preferred amines include polyalkyleneamines represented by the formula:



wherein n is 2 to 3 and m is 0 to 10. Illustrative examples include ethylene diamine, diethylene triamine, triethylene tetramine, tetraethylene pentamine, tetrapropylene pentamine, pentaethylene hexamine and the like, as well as the commercially available mixtures of such polyamines.

[022] The molybdenum-succinimide complex may be post-treated with a sulfur source at a suitable pressure and a temperature not to exceed 120°C to provide a sulfurized molybdenum-succinimide complex. The sulfurization step may be carried out for a period of from about 0.5 to 5 hours (e.g., 0.5 to 2 hours). Suitable sources of sulfur include elemental sulfur, hydrogen sulfide, phosphorus pentasulfide, organic polysulfides of formula R_2S_x where R is hydrocarbyl (e.g., C_1 to C_{10} alkyl) and x is at least 3, C_1 to C_{10} mercaptans, inorganic sulfides and polysulfides, thioacetamide, and thiourea.

Diphenylamine Antioxidants

[023] Diphenylamine are aromatic amine antioxidants and may have one or more carbon-based substituent groups. Diphenylamine-type oxidation inhibitors include, but are not limited to, alkylated diphenylamine, phenyl- α -naphthylamine, and alkyl or arylalkyl

substituted phenyl- α -naphthylamine, alkylated p-phenylene diamines, and tetramethyldiaminodiphenylamine.

[024] Specific examples of diphenylamine antioxidants include bis-nonylated diphenylamine, bis-octylated diphenylamine, and octylated/butylated diphenylamine, 4,4'-dioctyldiphenylamine, 4,4'-dinonyldiphenylamine, N-phenyl-1-naphthylamine, N-(4-tert-octylphenyl)-1-naphthylamine, and N-(4-octylphenyl)-1-naphthylamine.

[025] Diphenylamine antioxidants may be present at 0.01 to 5 wt. % of the lubricating oil composition, such as 0.01 to 4.5 wt. %, 0.01 to 4.0 wt. %, 0.01 to 3.5 wt. %, 0.01 to 3.0 wt. %, 0.01 to 2.5 wt. %, 0.01 to 2.0 wt. %, 0.01 to 1.5 wt. %, 0.01 to 1.0 wt. %, 0.01 to 0.5 wt. %, 0.5 to 5.0 wt. %, 0.5 to 4.5 wt. %, 0.5 to 4.0 wt. %, 0.5 to 3.5 wt. %, 0.5 to 3.0 wt. %, 0.5 to 2.5 wt. %, 0.5 to 2.0 wt. %, 0.5 to 1.5 wt. %, 0.5 to 1.0 wt. %, 1.0 to 5.0 wt. %, 1.0 to 4.5 wt. %, 1.0 to 4.0 wt. %, 1.0 to 3.5 wt. %, 1.0 to 3.0 wt. %, 1.0 to 2.5 wt. %, 1.0 to 2.0 wt. %, 1.0 to 1.5 wt. %, 1.5 to 5.0 wt. %, 1.5 to 4.5 wt. %, 1.5 to 4.0 wt. %, 1.5 to 3.5 wt. %, 1.5 to 3.0 wt. %, 1.5 to 2.5 wt. %, 1.5 to 2.0 wt. %, 2.0 to 5.0 wt. %, 2.0 to 4.5 wt. %, 2.0 to 4.0 wt. %, 2.0 to 3.5 wt. %, 2.0 to 3.0 wt. %, 2.0 to 2.5 wt. %, 2.5 to 5.0 wt. %, 2.5 to 4.5 wt. %, 2.5 to 4.0 wt. %, 2.5 to 3.5 wt. %, 2.5 to 3.0 wt. %, 3.0 to 5.0 wt. %, 3.0 to 4.5 wt. %, 3.0 to 4.0 wt. %, 3.0 to 3.5 wt. %, 3.5 to 5.0 wt. %, 3.5 to 4.5 wt. %, 3.5 to 4.0 wt. %, 4.0 to 5.0 wt. %, 4.0 to 4.5 wt. %, or 4.5 to 5.0 wt. %.

Hindered Phenol Antioxidant

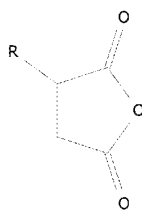
[026] The lubricating oil composition may comprise a hindered phenolic antioxidant. Examples of hindered phenolic antioxidants include 2,6-di-tert-butylphenol, 2,6-di-tert-butyl-p-cresol, and 2,6-di-tert-butyl-4-(2-octyl-3-propanoic) phenol.

[027] The hindered phenolic antioxidant may be present at 0.01 to 5 wt. % of the lubricating oil composition, such as 0.01 to 4.5 wt. %, 0.01 to 4.0 wt. %, 0.01 to 3.5 wt. %, 0.01 to 3.0 wt. %, 0.01 to 2.5 wt. %, 0.01 to 2.0 wt. %, 0.01 to 1.5 wt. %, 0.01 to 1.0 wt. %, 0.01 to 0.5 wt. %, 0.5 to 5.0 wt. %, 0.5 to 4.5 wt. %, 0.5 to 4.0 wt. %, 0.5 to 3.5 wt. %, 0.5 to 3.0 wt. %, 0.5 to 2.5 wt. %, 0.5 to 2.0 wt. %, 0.5 to 1.5 wt. %, 0.5 to 1.0 wt. %, 1.0 to 5.0 wt. %, 1.0 to 4.5 wt. %, 1.0 to 4.0 wt. %, 1.0 to 3.5 wt. %, 1.0 to 3.0 wt. %, 1.0 to 2.5 wt. %, 1.0 to 2.0 wt. %, 1.0 to 1.5 wt. %, 1.5 to 5.0 wt. %, 1.5 to 4.5 wt. %, 1.5 to 4.0 wt. %, 1.5 to 3.5 wt. %, 1.5 to 3.0 wt. %, 1.5 to 2.5 wt. %, 1.5 to 2.0 wt. %, 2.0 to 5.0 wt. %, 2.0 to 4.5 wt. %, 2.0 to 4.0 wt. %, 2.0 to 3.5 wt. %, 2.0 to 3.0 wt. %, 2.0 to 2.5 wt. %, 2.5 to 5.0 wt. %, 2.5 to 4.5 wt. %, 2.5 to 4.0 wt. %, 2.5 to 3.5 wt. %, 2.5 to 3.0 wt. %, 3.0 to 5.0 wt. %, 3.0 to 4.5 wt. %, 3.0 to 4.0 wt. %, 3.0 to 3.5 wt. %, 3.5 to 5.0 wt. %, 3.5 to 4.5 wt. %, 3.5 to 4.0 wt. %, 4.0 to 5.0 wt. %, 4.0 to 4.5 wt. %, or 4.5 to 5.0 wt. %.

Succinimides

[028] Optionally, the lubricating oil composition may include polyalkenyl succinimide dispersants such as those described herein. In general, the nitrogen content from the nitrogen-containing dispersant based on the lubricating oil composition is from about 0.010 wt % to about 0.30 wt % such as from about 0.050 to about 0.25 wt %, about 0.050 to about 0.20 wt %, and about 0.050 to about 0.15 wt %.

[029] In one embodiment, a polyalkenyl bis-succinimide can be obtained by reacting a polyalkenyl-substituted succinic anhydride below:



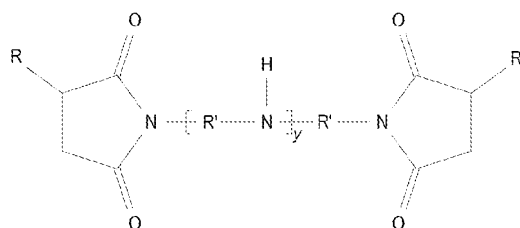
wherein R is a polyalkenyl substituent is derived from a polyalkene group having a number average molecular weight of from about 500 to about 3000, with a polyamine. In one embodiment, R is a polyalkenyl substituent derived from a polyalkene group having a number average molecular weight of from about 1000 to about 2500. In one embodiment, R is a polyisobutenyl substituent derived from a polyisobutene having a number average molecular weight of from about 500 to about 3000. In another embodiment, R is a polyisobutenyl substituent derived from a polyisobutene having a number average molecular weight of from about 1000 to about 2500.

[030] Suitable polyamines for use in preparing the bis-succinimide dispersants include polyalkylene polyamines. Such polyalkylene polyamines will typically contain about 2 to about 12 nitrogen atoms and about 2 to 24 carbon atoms. Particularly suitable polyalkylene polyamines are those having the formula: $\text{H}_2\text{N}-(\text{R}'\text{NH})_x-\text{H}$ wherein R' is a straight- or branched-chain alkylene group having 2 or 3 carbon atoms and x is 1 to 9. Representative examples of suitable polyalkylene polyamines include ethylenediamine, diethylenetriamine, triethylenetetraamine, tetraethylenepentamine, pentaethylene hexamine, and heavy polyamines (e.g., Ethyleneamine E-100, available from Huntsman Company).

[031] Generally, the polyalkenyl-substituted succinic anhydride is reacted with the polyamine at a temperature of about 130°C to about 220°C (e.g., 145°C to 175°C). The reaction can be carried out under an inert atmosphere, such as nitrogen or argon. Generally, a suitable molar charge of polyamine to polyalkenyl-substituted succinic anhydride is from about

0.35:1 to about 0.6:1 (e.g., 0.4:1 to 0.5:1). As used herein, the “molar charge of polyamine to polyalkenyl-substituted succinic anhydride” means the ratio of the number of moles of polyamine to the number of succinic groups in the succinic anhydride reactant.

[032] One class of suitable polyalkenyl succinimides may be represented by the following:



wherein R and R' are as described herein above and y is 1 to 11.

Post-Treatment of Polyalkenyl Succinimide

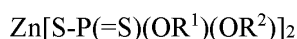
[033] In some embodiments, the succinimide dispersant may be post-treated by a reactive boron compound or organic carbonate.

[034] Suitable boron compounds that can be used as a source of boron include, for example, boric acid, a boric acid salt, a boric acid ester, and the like. Representative examples of a boric acid include orthoboric acid, metaboric acid, paraboric acid, and the like. Representative examples of a boric acid salt include ammonium borates, such as ammonium metaborate, ammonium tetraborate, ammonium pentaborate, ammonium octaborate, and the like. Representative examples of a boric acid ester include monomethyl borate, dimethyl borate, trimethyl borate, monoethyl borate, diethyl borate, triethyl borate, monopropyl borate, dipropyl borate, tripropyl borate, monobutyl borate, dibutyl borate, tributyl borate, and the like.

[035] In some embodiments, the lubricating oil composition includes both borated and non-borated succinimides. In some embodiments, the mass ratio of borated and non-borated succinimide is less than 1, such as less than 0.95, less than 0.90, less than 0.85, and less than 0.80.

Zinc Dithiophosphate (ZnDTP)

[036] The lubricating composition of the present disclosure may further include a zinc dithiophosphate (ZnDTP). Zinc dithiophosphates are antiwear agents that reduce wear of engine parts, having the following formula:



wherein R^1 and R^2 may be the same or different hydrocarbyl radicals having from 1 to 18 (e.g., 2 to 12) carbon atoms and including radicals such as alkyl, alkenyl, aryl, arylalkyl, alkaryl and cycloaliphatic radicals. In some embodiments, the R^1 and R^2 groups are alkyl groups having from 2 to 8 carbon atoms (e.g., the alkyl radicals may be ethyl, n-propyl, isopropyl, n-butyl, isobutyl, sec-butyl, n-pentyl, isopentyl, n-hexyl, isohexyl, or 2-ethylhexyl). In order to obtain oil solubility, the total number of carbon atoms (i.e., R^1+R^2) will be at least 5. The zinc dihydrocarbyl dithiophosphate can therefore include zinc dialkyl dithiophosphates (ZDDP). The zinc dialkyl dithiophosphate can be a primary ZnDTP containing primary alkyl groups, or secondary zinc dialkyl dithiophosphate containing secondary alkyl groups, or mixtures thereof. In some embodiments, the zinc dithiophosphate is a secondary zinc dithiophosphate.

[037] In some embodiments, the zinc dithiophosphate may be present in an amount sufficient to provide about 200 ppm to about 1500 ppm, about 300 ppm to about 1400 ppm, about 400 ppm to about 1300 ppm, about 500 ppm to about 1200 ppm, about 600 ppm to about 1100 ppm, about 700 ppm to about 1000 ppm, about 750 ppm to about 950 ppm, or about 800 to about 900 ppm of zinc to the lubricating composition.

Detergents

[038] The lubricating oil may further include a metal detergent such as a sulfonate or phenate detergent. In some embodiments, the sulfonate is a Ca or Mg sulfonate. In some embodiments, the phenate is a Ca or Mg sulfonate.

[039] A typical detergent is an anionic material that contains a long chain hydrophobic portion of the molecule and a smaller anionic or oleophobic hydrophilic portion of the molecule. The counterion is typically calcium or magnesium.

[040] Salts that contain stoichiometric amount of the metal are described as neutral salts and have a total base number (TBN) of from 0 to 80 mg KOH/g as measured by ASTM D-2896.

[041] Many detergents are overbased, containing large amounts of a metal base that is achieved by reacting an excess of a metal compound (e.g., a metal hydroxide or oxide) rich an acidic gas (e.g., carbon dioxide).

[042] Useful detergents can be neutral, mildly overbased, or highly overbased.

[043] In some embodiments, at least some detergent used in the detergent system may be overbased. Overbased detergents help neutralize acidic impurities produced by the combustion process and entrapped in the oil. The degree of overbasing generally depends on the ratio of metallic ion to anionic portion of the detergent on an equivalent basis.

[044] An overbased detergent will typically have a TBN of 10 mg KOH/g or higher as measured by ASTM D-2896, such as from 15 mg KOH/g or higher, 25 mg KOH/g or higher, 50 mg KOH/g or higher, 75 mg KOH/g or higher, 100 mg KOH/g or higher, 125 mg KOH/g or higher, 150 mg KOH/g or higher, 175 mg KOH/g or higher, 200 mg KOH/g or higher, 225 mg KOH/g or higher, 250 mg KOH/g or higher, 275 mg KOH/g or higher, 300 mg KOH/g or higher, 325 mg KOH/g or higher, 350 mg KOH/g or higher, 375 mg KOH/g or higher, 400 mg KOH/g or higher, 425 mg KOH/g or higher, 450 mg KOH/g or higher, 475 mg KOH/g or higher, 500 mg KOH/g or higher, 525 mg KOH/g or higher, 550 mg KOH/g or higher, 575 mg KOH/g or higher, 600 mg KOH/g or higher and 650 mg KOH/g or higher.

[045] In some embodiments, the overbased detergent has a TBN of 10 to 650 mg KOH/g as measured by ASTM D-2896, such as 10 to 600 mg KOH/g, 10 to 550 mg KOH/g, 10 to 500 mg KOH/g, 10 to 450 mg KOH/g, 10 to 400 mg KOH/g, 10 to 350 mg KOH/g, 10 to 300 mg KOH/g, 10 to 250 mg KOH/g, 10 to 200 mg KOH/g, 10 to 150 mg KOH/g, 10 to 100 mg KOH/g, 10 to 50 mg KOH/g, 50 to 650 mg KOH/g, 50 to 600 mg KOH/g, 50 to 550 mg KOH/g, 50 to 500 mg KOH/g, 50 to 450 mg KOH/g, 50 to 400 mg KOH/g, 50 to 350 mg KOH/g, 50 to 300 mg KOH/g, 50 to 250 mg KOH/g, 50 to 200 mg KOH/g, 50 to 150 mg KOH/g, 50 to 100 mg KOH/g, 100 to 650 mg KOH/g, 100 to 600 mg KOH/g, 100 to 550 mg KOH/g, 100 to 500 mg KOH/g, 100 to 450 mg KOH/g, 100 to 400 mg KOH/g, 100 to 350 mg KOH/g, 100 to 300 mg KOH/g, 100 to 250 mg KOH/g, 100 to 200 mg KOH/g, 100 to 150 mg KOH/g, 150 to 650 mg KOH/g, 150 to 600 mg KOH/g, 150 to 550 mg KOH/g, 150 to 500 mg KOH/g, 150 to 450 mg KOH/g, 150 to 400 mg KOH/g, 150 to 350 mg KOH/g, 150 to 300 mg KOH/g, 150 to 250 mg KOH/g, 150 to 200 mg KOH/g, 200 to 650 mg KOH/g, 200 to 600 mg KOH/g, 200 to 550 mg KOH/g, 200 to 500 mg KOH/g, 200 to 450 mg KOH/g, 200 to 400 mg KOH/g, 200 to 350 mg KOH/g, 200 to 300 mg KOH/g, 200 to 250 mg KOH/g, 250 to 650 mg KOH/g, 250 to 600 mg KOH/g, 250 to 550 mg KOH/g, 250 to 500 mg KOH/g, 250 to 450 mg KOH/g, 250 to 400 mg KOH/g, 250 to 350 mg KOH/g, 250 to 300 mg KOH/g, 300 to 650 mg KOH/g, 300 to 600 mg KOH/g, 300 to 550 mg KOH/g, 300 to 500 mg KOH/g, 300 to 450 mg KOH/g, 300 to 400 mg KOH/g, 300 to 350 mg KOH/g, 350 to 650 mg KOH/g, 350 to 600 mg KOH/g, 350 to 550 mg KOH/g, 350 to 500 mg KOH/g, 350 to 450 mg KOH/g, 350 to 400 mg KOH/g, 400 to 650 mg KOH/g, 400 to 600 mg KOH/g, 400 to 550 mg KOH/g, 400 to 500 mg KOH/g, 400 to 450 mg KOH/g, 450 to 650 mg KOH/g, 450 to 600 mg KOH/g, 450 to 550 mg KOH/g, 450 to 500 mg KOH/g, 500 to 650 mg KOH/g, 500 to 600 mg KOH/g, 500 to 550 mg KOH/g, 550 to 650 mg KOH/g, 550 to 600 mg KOH/g, or 600 to 650 mg KOH/g.

[046] In some embodiments, the overbased detergent has a TBN of 10 to 150 mg KOH/g, such as from 10 to 140 mg KOH/g, 10 to 130 mg KOH/g, 10 to 120 mg KOH/g, 10 to 110 mg KOH/g, 10 to 100 mg KOH/g, 10 to 90 mg KOH/g, 10 to 80 mg KOH/g, 10 to 70 mg KOH/g, 10 to 60 mg KOH/g, 10 to 50 mg KOH/g, 10 to 40 mg KOH/g, 10 to 30 mg KOH/g, 10 to 20 mg KOH/g, 20 to 150 mg KOH/g, 20 to 140 mg KOH/g, 20 to 130 mg KOH/g, 20 to 120 mg KOH/g, 20 to 110 mg KOH/g, 20 to 100 mg KOH/g, 20 to 90 mg KOH/g, 20 to 80 mg KOH/g, 20 to 70 mg KOH/g, 20 to 60 mg KOH/g, 20 to 50 mg KOH/g, 20 to 40 mg KOH/g, 20 to 30 mg KOH/g, 30 to 150 mg KOH/g, 30 to 140 mg KOH/g, 30 to 130 mg KOH/g, 30 to 120 mg KOH/g, 30 to 110 mg KOH/g, 30 to 100 mg KOH/g, 30 to 90 mg KOH/g, 30 to 80 mg KOH/g, 30 to 70 mg KOH/g, 30 to 60 mg KOH/g, 30 to 50 mg KOH/g, 30 to 40 mg KOH/g, 40 to 150 mg KOH/g, 40 to 140 mg KOH/g, 40 to 130 mg KOH/g, 40 to 120 mg KOH/g, 40 to 110 mg KOH/g, 40 to 100 mg KOH/g, 40 to 90 mg KOH/g, 40 to 80 mg KOH/g, 40 to 70 mg KOH/g, 40 to 60 mg KOH/g, 40 to 50 mg KOH/g, 50 to 150 mg KOH/g, 50 to 140 mg KOH/g, 50 to 130 mg KOH/g, 50 to 120 mg KOH/g, 50 to 110 mg KOH/g, 50 to 100 mg KOH/g, 50 to 90 mg KOH/g, 50 to 80 mg KOH/g, 50 to 70 mg KOH/g, 50 to 60 mg KOH/g, 60 to 150 mg KOH/g, 60 to 140 mg KOH/g, 60 to 130 mg KOH/g, 60 to 120 mg KOH/g, 60 to 110 mg KOH/g, 60 to 100 mg KOH/g, 60 to 90 mg KOH/g, 60 to 80 mg KOH/g, 60 to 70 mg KOH/g, 80 to 150 mg KOH/g, 80 to 140 mg KOH/g, 80 to 130 mg KOH/g, 80 to 120 mg KOH/g, 80 to 110 mg KOH/g, 80 to 100 mg KOH/g, 80 to 90 mg KOH/g, 90 to 150 mg KOH/g, 90 to 140 mg KOH/g, 90 to 130 mg KOH/g, 90 to 120 mg KOH/g, 90 to 110 mg KOH/g, 90 to 100 mg KOH/g, 100 to 150 mg KOH/g, 100 to 140 mg KOH/g, 100 to 130 mg KOH/g, 100 to 120 mg KOH/g, 100 to 110 mg KOH/g, 110 to 150 mg KOH/g, 110 to 140 mg KOH/g, 110 to 130 mg KOH/g, 110 to 120 mg KOH/g, 120 to 150 mg KOH/g, 120 to 140 mg KOH/g, 120 to 130 mg KOH/g, 130 to 150 mg KOH/g, 130 to 140 mg KOH/g, or 140 to 150 mg KOH/g,

Other Additives

[047] The present lubricating oil compositions may also contain conventional lubricant additives for imparting auxiliary functions to give a finished lubricating oil composition in which these additives are dispersed or dissolved. For example, the lubricating oil compositions can be blended with ashless dispersants, anti-wear agents, dehazing agents, demulsifying agents, friction modifiers, pour point depressants, viscosity modifiers, antifoaming agents, co-solvents, package compatibilizers, dyes, extreme pressure agents and the like and mixtures thereof. A variety of the additives are known and commercially available. These additives, or their analogous compounds, can be employed for the preparation of the lubricating oil compositions of the invention by the usual blending procedures.

[048] Each of the foregoing additives, when used, is used at a functionally effective amount to impart the desired properties to the lubricant. Thus, for example, if an additive is an ashless dispersant, a functionally effective amount of this ashless dispersant would be an amount sufficient to impart the desired dispersancy characteristics to the lubricant. Generally, the concentration of each of these additives, when used, may range, unless otherwise specified, from about 0.001 to about 20 wt. %, such as about 0.01 to about 10 wt. %.

Lubricating Oil

[049] The oil of lubricating viscosity (sometimes referred to as “base stock” or “base oil”) is the primary liquid constituent of a lubricant, into which additives and possibly other oils are blended, for example to produce a final lubricant (or lubricant composition). A base oil, which is useful for making concentrates as well as for making lubricating oil compositions therefrom, may be selected from natural (vegetable, animal or mineral) and synthetic lubricating oils and mixtures thereof.

[050] Oils used as the base oil will be selected or blended depending on the desired end use and the additives in the finished oil to give the desired grade of engine oil. In one embodiment, the lubricating oil composition is a multi-grade oil for heavy duty or passenger car. The multi-grade oil may have a Society of Automotive Engineers (SAE) viscosity grade of 0W-8, 0W-12, 0W-16, 0W-20, 0W-30, 0W-40, 0W-50, 0W-60, 5W, 5W-20, 5W-30, 5W-40, 5W-50, 5W-60, 10W, 10W-20, 10W-30, 10W-40, 10W-50, 15W, 15W-20, 15W-30, 15W-40, 20W-40 or 20W-50.

[051] Definitions for the base stocks and base oils in this disclosure are the same as those found in American Petroleum Institute (API) Publication 1509 Annex E (“API Base Oil Interchangeability Guidelines for Passenger Car Motor Oils and Diesel Engine Oils,” February 2022). Group I base stocks contain less than 90% saturates and/or greater than 0.03% sulfur and have a viscosity index greater than or equal to 80 and less than 120 using the test methods specified in Table E-1. Group II base stocks contain greater than or equal to 90% saturates and less than or equal to 0.03% sulfur and have a viscosity index greater than or equal to 80 and less than 120 using the test methods specified in Table E-1. Group III base stocks contain greater than or equal to 90% saturates and less than or equal to 0.03% sulfur and have a viscosity index greater than or equal to 120 using the test methods specified in Table E-1. Group IV base stocks are polyalphaolefins (PAO). Group V base stocks include all other base stocks not included in Group I, II, III, or IV.

[052] Natural oils include animal oils, vegetable oils (e.g., castor oil and lard oil), and mineral oils. Animal and vegetable oils possessing favorable thermal oxidative stability can be

used. Of the natural oils, mineral oils are preferred. Mineral oils vary widely as to their crude source, for example, as to whether they are paraffinic, naphthenic, or mixed paraffinic-naphthenic. Oils derived from coal or shale are also useful. Natural oils vary also as to the method used for their production and purification, for example, their distillation range and whether they are straight run or cracked, hydrorefined, or solvent extracted.

[053] Synthetic oils include hydrocarbon oil. Hydrocarbon oils include oils such as polymerized and interpolymerized olefins (e.g., polybutylenes, polypropylenes, propylene isobutylene copolymers, ethylene-olefin copolymers, and ethylene-alphaolefin copolymers). Polyalphaolefin (PAO) oil base stocks are commonly used synthetic hydrocarbon oil. By way of example, PAOs derived from C₈ to C₁₄ olefins, e.g., C₈, C₁₀, C₁₂, C₁₄ olefins or mixtures thereof, may be utilized.

[054] Other useful fluids for use as base oils include non-conventional or unconventional base stocks that have been processed, preferably catalytically, or synthesized to provide high performance characteristics.

[055] Non-conventional or unconventional base stocks/base oils include one or more of a mixture of base stock(s) derived from one or more Gas-to-Liquids (GTL) materials, as well as isomerase/isodewaxate base stock(s) derived from natural wax or waxy feeds, mineral and or non-mineral oil waxy feed stocks such as slack waxes, natural waxes, and waxy stocks such as gas oils, waxy fuels hydrocracker bottoms, waxy raffinate, hydrocrackate, thermal crackates, or other mineral, mineral oil, or even non-petroleum oil derived waxy materials such as waxy materials received from coal liquefaction or shale oil, and mixtures of such base stocks. Other base oils include Coal to liquid (CTL) products and alkyl-naphthalene.

[056] Base oils for use in the lubricating oil compositions of present disclosure are any of the variety of oils corresponding to API Group I, Group II, Group III, Group IV, and Group V oils, and mixtures thereof, preferably API Group II, Group III, Group IV, and Group V oils, and mixtures thereof, more preferably the Group III to Group V base oils due to their exceptional volatility, stability, viscometric and cleanliness features.

[057] The lubricating oil composition may have a high temperature shear (HTHS) viscosity at 150° C of 5.2 cP or less, such as 5.1 cP or less, 5.0 cP or less, 4.5 cP or less, 4.0 cP or less, 3.9 cP or less, 3.8 cP or less, 3.7 cP or less, 3.6 cP or less, 3.5 cP or less, 3.4 cP or less, 3.3 cP or less, 3.2 cP or less, 3.1 cP or less, 3.0 cP or less, 2.9 cP or less, 2.8 cP or less, 2.7 cP or less, 2.6 cP or less, 2.5 cP or less, 2.4 cP or less, 2.3 cP or less, 2.2 cP or less, 2.1 cP or less, 2.0 cP or less, 1.9 cP or less, 1.8 cP or less, 1.7 cP or less, 1.6 cP or less, 1.5 cP or less, 1.4 cP or less, 1.3 cP or less, 1.2 cP or less, 1.1 cP or less, or 1.0 cP or less. In some embodiments,

the lubricating oil composition may have a HTHS at 150°C from 1.0 to 5.2 cP, such as from 1.0 to 4.5 cP, 1.0 to 4.0 cP, 1.0 to 2.9 cP, 1.3 to 2.9 cP, 1.0 to 2.6 cP, 1.3 to 2.6 cP, 1.0 cP to 2.3 cP, 1.3 cP to 2.3 cP, 1.0 cP to 2.0 cP, 1.3 cP to 2.3 cP, 1.0 cP to 1.7 cP, or 1.3 cP to 1.7 cP. The lubricating oil composition may have a viscosity index of at least 135 (e.g., 135 to 400, or 135 to 250), at least 150 (e.g., 150 to 400, 150 to 250), at least 165 (e.g., 165 to 400, or 165 to 250), at least 190 (e.g., 190 to 400, or 190 to 250), or at least 200 (e.g., 200 to 400, or 200 to 250). If the viscosity index of the lubricating oil composition is less than 135, it may be difficult to improve fuel efficiency while maintaining the HTHS viscosity at 150° C. If the viscosity index of the lubricating oil composition exceeds 400, evaporation properties may be reduced, and deficits due to insufficient solubility of the additive and matching properties with a seal material may be caused.

[058] The base oil may have a kinematic viscosity at 100°C (ASTM D445) in a range of 1.4 to 20 mm²/s such as 3 to 12 mm²/s, such as 3 to 11 mm²/s, 3 to 10 mm²/s, 3 to 9 mm²/s, 3 to 8 mm²/s, 3 to 7 mm²/s, 3 to 6 mm²/s, 3 to 5 mm²/s, 3 to 4 mm²/s, 4 to 12 mm²/s, 4 to 11 mm²/s, 4 to 10 mm²/s, 4 to 9 mm²/s, 4 to 8 mm²/s, 4 to 7 mm²/s, 4 to 6 mm²/s, 4 to 5 mm²/s, 5 to 12 mm²/s, 5 to 11 mm²/s, 5 to 10 mm²/s, 5 to 9 mm²/s, 5 to 8 mm²/s, 5 to 7 mm²/s, 5 to 6 mm²/s, 6 to 12 mm²/s, 6 to 11 mm²/s, 6 to 10 mm²/s, 6 to 9 mm²/s, 6 to 8 mm²/s, 6 to 7 mm²/s, 7 to 12 mm²/s, 7 to 11 mm²/s, 7 to 10 mm²/s, 7 to 9 mm²/s, 7 to 10 mm²/s, 7 to 9 mm²/s, 7 to 8 mm²/s, 8 to 12 mm²/s, 8 to 11 mm²/s, 8 to 10 mm²/s, 8 to 9 mm²/s, 9 to 12 mm²/s, 9 to 11 mm²/s, 9 to 10 mm²/s, 10 to 12 mm²/s, 10 to 11 mm²/s, or 11 to 12 mm²/s.

[059] The following non-limiting examples are illustrative of the present invention. Brief descriptions of how the examples were prepared are provided.

EXAMPLES

[060] Lubricating oil samples were tested for antirust (Antirust D1748) and water separation performance (Modified ASTM D7563). Brief description of the test is provided below.

Antirust (ASTM D1748)

[061] The Humidity Cabinet Rust Test (ASTM D1748) was used to evaluate antirust performance. The test was run at 48.9°C (120°F) for specified number of hours and measures the formation of rust in metal panels soaked in the lubricating oil samples. The oil fails or passes the test based on the size and number of rust dots on the surfaces of panels.

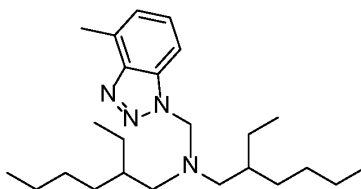
[062] Each lubricating oil composition (SAE 10W-30 or 15W-40) was blended with the following baseline components:

- a) Group II base oils:
- b) Mixture borated and non-borated succinimide dispersants
- c) Mixture of overbased phenate and sulfonate detergents
- d) ZnDTP
- e) Molybdenum succinimide
- f) Phenolic antioxidant

[063] Each lubricating oil sample includes the baseline and one of the following copper corrosion inhibitors.

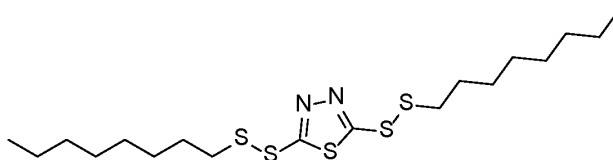
Corrosion Inhibitor A

[064] Corrosion inhibitor A is a benzotriazole or a tolytriazole derivative commercially available as IRGAMET® 39 from BASF. The chemical name of this corrosion inhibitor is 1-[bis(2-ethylhexyl)aminomethyl]-4-methylbenzotriazole. The structure is shown below:



Corrosion Inhibitor B

[065] Corrosion inhibitor B is an ashless dialkyl thiadiazole commercially available as HITEC® 4313 from Afton Chemical. The chemical name of this corrosion inhibitor is 2,5-bis(octylsulfanyl)-1,3,4-thiadiazole. The structure is shown below:



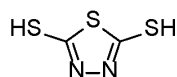
Corrosion Inhibitor C

[066] Corrosion inhibitor C is a thiadiazole commercially available from Tianhe. The structure is shown below:



Corrosion Inhibitor D

[067] Corrosion inhibitor D is a thiadiazole derivative commercially available as CUVAN® 826 from Vanderbilt. The chemical name of this corrosion inhibitor is 2,5-dimercapto-1,3,4-thiadiazole. The structure is shown below:



Corrosion Inhibitor E

[068] Corrosion inhibitor E is a thiadiazole derivative commercially available from Afton Chemical as HITEC® 4312. It is an ashless dialkyl thiadiazole derivative. Its chemical name is 2,5-dimercapto-1,3,4-thiadiazole derivative.

[069] Table 1 below summarizes comparative lubricating oil samples and the test results. The amount of corrosion inhibitor is given in terms of wt.% based on the total amount of the lubricating oil composition. Table 2 below shows test results at various treat rates of Corrosion Inhibitor A.

Modified High Temperature Corrosion Bench Test, HTCBT (Modified ASTM D-6594)

[070] The ASTM D6594 HTCBT test is used to test diesel engine lubricants to determine their tendency to corrode various metals, specifically alloys of lead and copper commonly used in cam followers and bearings. Four metal specimens of copper, lead, tin and phosphor bronze are immersed in a measured amount of engine oil. The oil, at an elevated temperature (170 °C), is blown with air (5 l/h) for a period of time (168 h) with 6% of water. When the test is completed, the copper specimen and the stressed oil are examined to detect corrosion and corrosion products, respectively. The concentrations of copper, lead, and tin in the new oil and stressed oil and the respective changes in metal concentrations are reported.

Table 1

	Comp Ex 1	Comp Ex 2	Comp Ex 3	Comp Ex 4	Comp Ex 5
Corrosion Inhibitor A (wt.%)	-	-	-	-	-
Corrosion Inhibitor B (wt.%)	0.1				
Corrosion Inhibitor C (wt.%)		0.1			
Corrosion Inhibitor D (wt.%)			0.1		
Corrosion Inhibitor E (wt.%)				0.1	0.2
HTCBT-Cu	145	80	172	87	90
Anti Rust	Fail	Fail	Fail	Fail	Fail

Table 2

	Ex 1	Ex 2	Ex 3	Ex 4	Ex 5
Corrosion Inhibitor A (wt.%)	0.10	0.025	0.05	0.075	0.15
HTCBT-Cu	38	29	35	40	34
Anti Rust	Pass	Pass	Pass	Pass	Pass

[071] For the sake of brevity, only certain ranges are explicitly disclosed herein. However, ranges from any lower limit may be combined with any upper limit to recite a range not explicitly recited, as well as, ranges from any lower limit may be combined with any other lower limit to recite a range not explicitly recited, in the same way, ranges from any upper limit may be combined with any other upper limit to recite a range not explicitly recited. Additionally, within a range includes every point or individual value between its end points even though not explicitly recited. Thus, every point or individual value may serve as its own lower or upper limit combined with any other point or individual value or any other lower or upper limit, to recite a range not explicitly recited.

[072] Likewise, the term “comprising” is considered synonymous with the term “including.” Likewise whenever a composition, an element or a group of elements is preceded with the transitional phrase “comprising,” it is understood that we also contemplate the same composition or group of elements with transitional phrases “consisting essentially of,” “consisting of,” “selected from the group of consisting of,” or “is” preceding the recitation of the composition, element, or elements and vice versa.

[073] The terms "a" and "the" as used herein are understood to encompass the plural as well as the singular.

[074] Various terms have been defined above. To the extent a term used in a claim is not defined above, it should be given the broadest definition persons in the pertinent art have given that term as reflected in at least one printed publication or issued patent. Furthermore, all patents, test procedures, and other documents cited in this application are fully incorporated by reference to the extent such disclosure is not inconsistent with this application and for all jurisdictions in which such incorporation is permitted.

[075] The foregoing description of the disclosure illustrates and describes the present disclosure. Additionally, the disclosure shows and describes only the preferred embodiments but, as mentioned above, it is to be understood that the disclosure is capable of use in various other combinations, modifications, and environments and is capable of changes or modifications within the scope of the concept as expressed herein, commensurate with the above teachings and/or the skill or knowledge of the relevant art. While the foregoing is directed to embodiments of the present disclosure, other and further embodiments of the disclosure may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

[076] It is understood that when combinations, subsets, groups, etc. of elements are disclosed (e.g., combinations of components in a composition, or combinations of steps in a method), that while specific reference of each of the various individual and collective combinations and permutations of these elements may not be explicitly disclosed, each is specifically contemplated and described herein.

[077] The embodiments described hereinabove are further intended to explain best modes known of practicing it and to enable others skilled in the art to utilize the disclosure in such, or other, embodiments and with the various modifications required by the particular applications or uses. Accordingly, the description is not intended to limit it to the form disclosed herein. Also, it is intended that the appended claims be construed to include alternative embodiments.

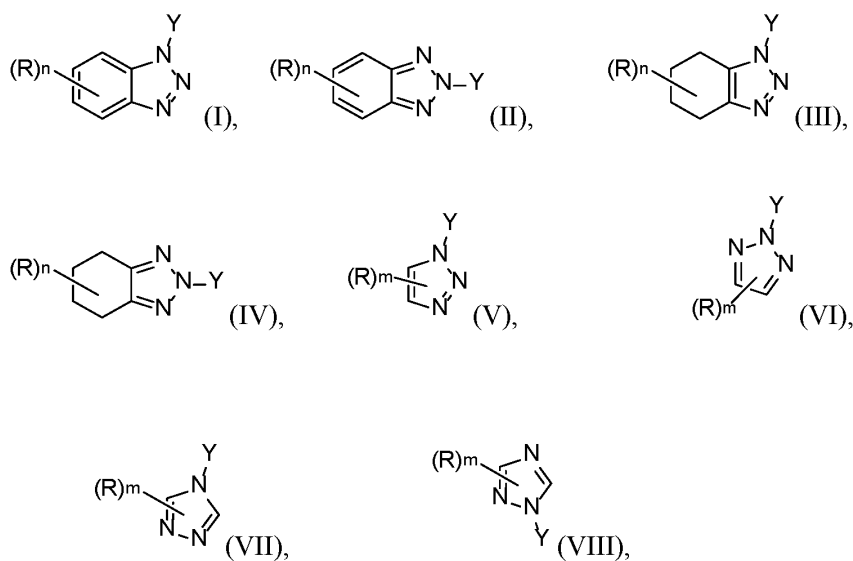
CLAIMS

1. A method of reducing corrosion and/or rust in hydrogen fuel or methanol fuel engine, the method comprising:

lubricating the hydrogen fuel or methanol fuel engine with a lubricating oil composition comprising:

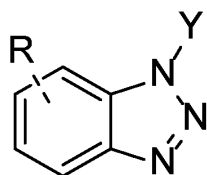
major amount of an oil of lubricating viscosity; and
an aromatic triazole compound.

2. The method of claim 1, wherein the aromatic triazole is one of the following structures:



wherein, n is an integer from 0 to 4, m is 0, 1, or 2, R is a C1-C24 hydrocarbyl group and Y is $-R^1$ or $-(R^2)_p-NR^3R^3$ where $-R^1$ is a C1-C24 hydrocarbyl group, $-R^2-$ is a C1-C24 hydrocarbylene group, p is 0 or 1, and each $-R^3$ is independently hydrogen or C1-C24 hydrocarbyl group.

3. The method of claim 1, wherein the aromatic triazole compound is represented by the following structure:



wherein R is a hydrocarbyl group and Y is hydrogen, R^1 , or $(R^2)_p-NR^3R^4$, wherein R^1 is a C1-C20 hydrocarbyl group, R^2 is a C1-C20 hydrocarbylene group, R^3 and R^4 are independently hydrogen or C1-C20 hydrocarbyl group, and p is 0 or 1; and wherein the triazole compound has a molecular weight of about 70 to about 1000 g/mol.

4. The method of claim 1, wherein the triazole compound is a tolytriazole or a derivative thereof.

5. The method of claim 1, wherein the triazole compound is a benzotriazole.

6. The method of claim 1, wherein the triazole compound is present in an amount from about 0.01 wt.% to about 10 wt.% based on the total lubricating oil composition.

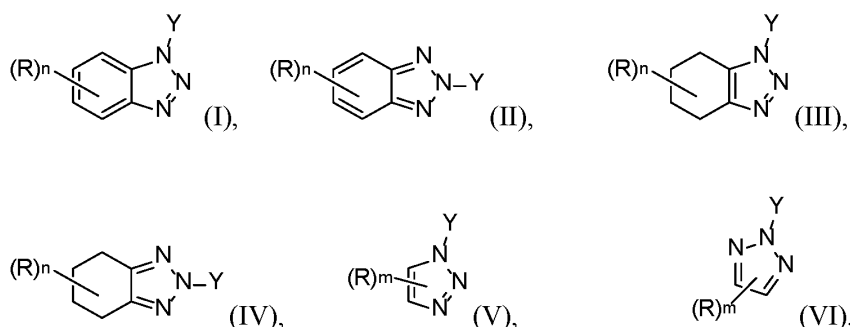
7. The method of claim 1, wherein the triazole compound is 1-[[bis(2-ethylhexyl)aminomethyl]-4-methylbenzotriazole.

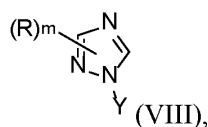
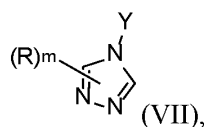
8. A method for maintaining emulsion stability in a hydrogen fuel or methanol fuel engine, the method comprising:

lubricating the hydrogen fuel or methanol fuel engine with a lubricating oil composition comprising:

major amount of an oil of lubricating viscosity; and
an aromatic triazole compound.

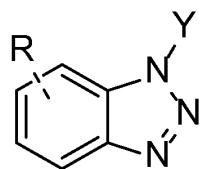
9. The method of claim 8, wherein the aromatic triazole is one of the following structures:





wherein, n is an integer from 0 to 4, m is 0, 1, or 2, R is a C1-C24 hydrocarbyl group and Y is $-R^1$ or $-(R^2)_p-NR^3R^4$ where $-R^1$ is a C1-C24 hydrocarbyl group, $-R^2-$ is a C1-C24 hydrocarbylene group, p is 0 or 1, and each $-R^3$ is independently hydrogen or C1-C24 hydrocarbyl group.

10. The method of claim 8, wherein the aromatic triazole compound is represented by the following structure:



wherein R is a hydrocarbyl group and Y is hydrogen, R^1 , or $(R^2)_p-NR^3R^4$, wherein R^1 is a C1-C20 hydrocarbyl group, R^2 is a C1-C20 hydrocarbylene group, R^3 and R^4 are independently hydrogen or C1-C20 hydrocarbyl group, and p is 0 or 1; and wherein the triazole compound has a molecular weight of about 70 to about 1000 g/mol.

11. The method of claim 8, wherein the triazole compound is a tolytriazole or a derivative thereof.

12. The method of claim 8, wherein the triazole compound is a benzotriazole.

13. The method of claim 8, wherein the triazole compound is present in an amount from about 0.01 wt.% to about 10 wt.% based on the total lubricating oil composition.

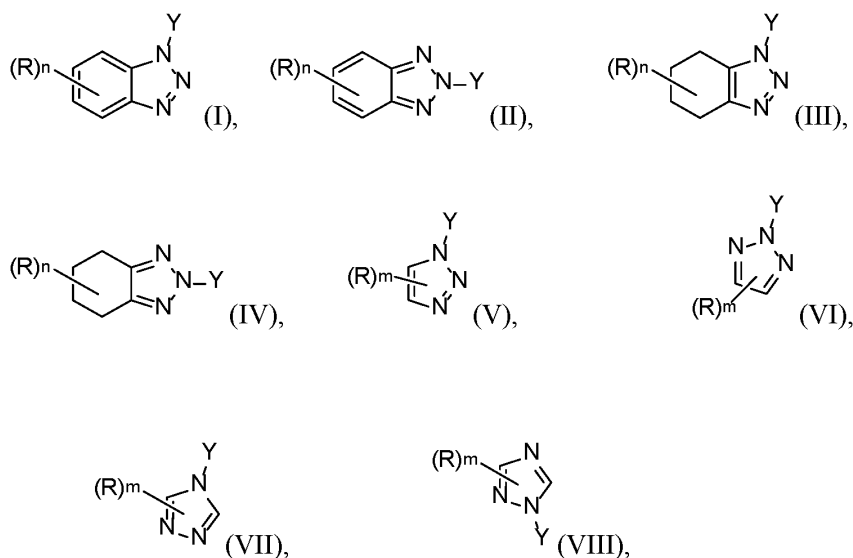
14. The method of claim 8, wherein the triazole compound is 1-[bis(2-ethylhexyl)aminomethyl]-4-methylbenzotriazole.

15. Use of a lubricating oil composition to inhibit corrosion in hydrogen fuel or methanol fuel engine, wherein the lubricating oil composition comprises:

major amount of an oil of lubricating viscosity; and

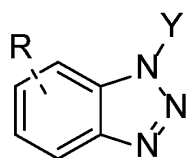
an aromatic triazole compound.

16. The use of claim 15, wherein the aromatic triazole compound is one of the following structures:



wherein, n is an integer from 0 to 4, m is 0, 1, or 2, R is a C1-C24 hydrocarbyl group and Y is $-R^1$ or $-(R^2)_p-NR^3R^4$ where $-R^1$ is a C1-C24 hydrocarbyl group, $-R^2-$ is a C1-C24 hydrocarbylene group, p is 0 or 1, and each $-R^3$ is independently hydrogen or C1-C24 hydrocarbyl group.

17. The use of claim 15, wherein the aromatic triazole compound is represented by the following structure:



wherein R is a hydrocarbyl group and Y is hydrogen, R^1 , or $(R^2)_p-NR^3R^4$, wherein R^1 is a C1-C20 hydrocarbyl group, R^2 is a C1-C20 hydrocarbylene group, R^3 and R^4 are independently hydrogen or C1-C20 hydrocarbyl group, and p is 0 or 1; and wherein the triazole compound has a molecular weight of about 70 to about 1000 g/mol.

18. The use of claim 15, wherein the triazole compound is a polytriazole or a derivative thereof.
19. The use of claim 15, wherein the triazole compound is a benzotriazole.
20. The use of claim 15, wherein the triazole compound is present in an amount from about 0.01 wt.% to about 10 wt.% based on the total lubricating oil composition.
21. The use of claim 15, wherein the triazole compound is 1-[bis(2-ethylhexy)aminomethyl]-4-methylbenzotriazole.