

ALKYL PHENOL BASED POLYETHER DERIVED COMPOUNDS AS LUBRICANT ADDITIVES

TECHNICAL FIELD

[001] This disclosure relates to lubricant additive compositions and lubricating oil compositions containing the same. More specifically, this disclosure describes lubricant additives that improve engine performance.

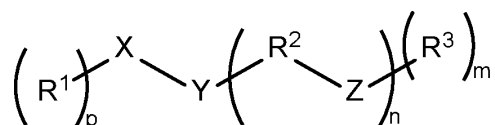
BACKGROUND

[002] While automotive engines are constantly being improved, developing new engine oils and additive packages offers a quicker and/or more cost-effective path to improving performance factors such as fuel efficiency, oxidative stability, volatility, and more.

[003] In particular, oxidative stability is an important as poor oxidative stability often leads to deposit formation which in turn can cause stalling and poor acceleration. Additionally, the deposits can increase fuel consumption as well as increase production of harmful exhaust pollutants.

SUMMARY

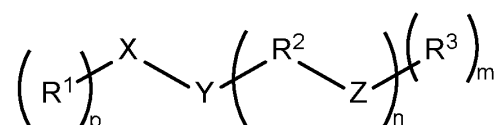
[004] In one aspect, there is provided a lubricating oil composition comprising: a major amount of base oil; and a lubricant additive having the following structure:



wherein each R^1 is independently a hydrocarbyl group having 10 to 400 carbons; X is an alkyl, aryl, or heteroaromatic group having 1 to 10 carbons; Y is nitrogen, oxygen, or sulfur; each R^2 is independently a hydrocarbyl group having 1 to 9 carbons; Z is nitrogen, oxygen, or sulfur; and each R^3 is independently a hydrogen or hydrocarbyl

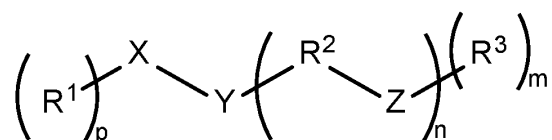
group having 1 to 9 carbons with one or more nitrogen, oxygen, or sulfur functionalization, wherein p is 1 to 3, n is 1 to 20 and m is 1 to 3.

[005] In another aspect, there is provided a method of lubricating an engine, the method comprising lubricating the engine with a lubricating oil composition comprising: a major amount of base oil; and a lubricant additive having the following structure:



wherein each R^1 is independently a hydrocarbyl group having 10 to 400 carbons; X is an alkyl, aryl, or heteroaromatic group having 1 to 10 carbons; Y is nitrogen, oxygen, or sulfur; each R^2 is independently a hydrocarbyl group having 1 to 9 carbons; Z is nitrogen, oxygen, or sulfur; and each R^3 is independently a hydrogen or hydrocarbyl group having 1 to 9 carbons with one or more nitrogen, oxygen, or sulfur functionalization, wherein p is 1 to 3, n is 1 to 20 and m is 1 to 3.

[006] In yet another aspect, there is provided a method for improving piston cleanliness or oxidation inhibition in an engine, the method comprising lubricating the engine with a lubricating oil composition comprising: a major amount of base oil; and a lubricant additive having the following structure:



wherein each R^1 is independently a hydrocarbyl group having 10 to 400 carbons; X is an alkyl, aryl, or heteroaromatic group having 1 to 10 carbons; Y is nitrogen, oxygen, or sulfur; each R^2 is independently a hydrocarbyl group having 1 to 9 carbons; Z is nitrogen, oxygen, or sulfur; and each R^3 is independently a hydrogen or hydrocarbyl group having 1 to 9 carbons with one or more nitrogen, oxygen, or sulfur functionalization, wherein p is 1 to 3, n is 1 to 20 and m is 1 to 3.

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 lubricant additive composition(s) that prevents or reduces deposit formation (e.g., reduce soot deposits on pistons) thus improving cleanliness in engines. The lubricant additive may be formulated in base oil along with other lubricant additives to impart performance benefits to the resulting lubricating oil composition.

[009] In some embodiments, the present disclosure relates to engine flush products containing the additive, mixed products containing the additive and used lubricating oil composition, and methods of using the same.

[010] In some embodiments, the engine flush product is an aftermarket additive package wherein the additive is dissolved in solvent. The aftermarket additive package is suitable for rapidly cleaning or removing accumulated deposits, sludge, and other gunk from an internal combustion engine.

[011] An engine flush process can remove sludge, heavy deposits, and/or other gunk that may have been built up from engine oil. A typical engine flush process involves adding the additive as an aftermarket additive (e.g., engine flush product) to an internal combustion engine through the oil-filler port. After the engine is allowed to idle, the additive is added to mix with the existing lubricating oil composition which has "used base oil". This mixed product can dissolve or clean sludge, heavy deposits, and/or gunk residing in the engine. The mixed product is then drained along with the dissolved sludge, deposit, and/or gunk.

[012] In some embodiments, the lubricating oil composition disclosed herein can be used as a rapid cleaning fluid. The rapid cleaning fluid can be used during rapid cleaning service to remove accumulated deposits, sludge, and other gunk from an

internal combustion engine. A rapid cleaning service can remove sludge, heavy deposits, and/or other insoluble material that may have been built up over time.

[013] The cleaning process may be comprised of using the lubricant in the engine sump or crankcase and circulating the lubricating oil without starting the engine. An additional step would include circulating the lubricating oil and allowing it to soak under a static condition for 15 minutes, 30 minutes, 1 hour, 1.5 hours, 2 hours, 3 hours, 4 hours, 5 hours, 6 hours, 7, hours, 8 hours, 9 hours, 10 hours, 11 hours, 12 hours, 16 hours, 20 hours, 24 hours, 2 days, 3 days, 4 days, 5 days, 6 days, or a week. Another cleaning step could include starting and operating the engine at any running condition appropriate for the engine design and fuel for 15 minutes, 30 minutes, 1 hour, 1.5 hours, 2 hours, 3 hours, 4 hours, 5 hours, 6 hours, 7, hours, 8 hours, 9 hours, 10 hours, 11 hours, 12 hours, 16 hours, 20 hours, 24 hours, 2 days, 3 days, 4 days, 5 days, 6 days, or a week. In some embodiments, the lubricating oil composition disclosed herein may be used for removing existing deposits from the crankcase, rocker cover, camshaft region, timing gear cover, cylinder head, combustion chamber, piston rings and/or ring grooves in an internal combustion engine.

[014] When used during a rapid cleaning service, the lubricating oil composition can require the lubricant additive at a higher concentration than is typically used during regular maintenance. This lubricating oil with higher amounts of the deposit cleaning lubricant additive is used to lubricate and clean the engine. The resulting mixed product (concentrated lubricating oil and deposits) can then be flushed. The flushing step typically occurs after completion of the cleaning step.

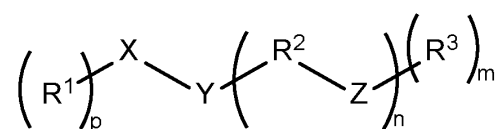
[015] In some embodiments, the cleaning step of the rapid cleaning service involves lubricating the engine with the lubricating oil composition for 15 minutes, 30 minutes, 1 hour, 1.5 hours, 2 hours, 3 hours, 4 hours, 5 hours, 6 hours, 7, hours, 8 hours, 9 hours, 10 hours, 11 hours, 12 hours, 16 hours, 20 hours, 24 hours, 2 days, 3 days, 4 days, 5 days, 6 days, or a week. The exact amount of time can vary depending on a number of factors such as, but not limited, the size of engine, the amount of deposits in the engine, desired level of cleanliness, and so forth.

[016] In some embodiments, the flushing takes place after 5 minutes, after 15 minutes, after 30 minutes, after 45 minutes, after 1 hour, after 2 hours, after three 3, after 4 hours, after 5 hours, after 6 hours, after 8 hours, after 12 hours, after 16 hours, after 24 hours, after 2 days, after 3 days, after 4 days, after 1 week, after 2 weeks, after 3 weeks, after 4 weeks, after 6 weeks, after 8 weeks from the cleaning step. In some embodiments, the flushing step can occur up to a period equivalent to about 25% of the OEM recommended oil change interval period.

[017] In some embodiments, the lubricating oil composition, rapid cleaning fluid, or engine flush product disclosed herein has a total base number (TBN) of 2 to 200 mgKOH/g such as 2 to 175, 2 to 150, 2 to 100, 5 to 200, 5 to 175, 5 to 150, 5 to 100, 10 to 200, 10 to 175, 10 to 150, 10 to 100, 50 to 200, 50 to 175, 50 to 150, and 50 to 100.

Lubricant Additive

[018] The lubricant additive composition of the present disclosure is a dispersant that can be represented by the following generalized chemical structure I:



Structure I

wherein each R^1 is independently a hydrocarbyl group having 10 to 400 carbons; X is an alkyl, aryl, or heteroaromatic group having 1 to 10 carbons; Y is nitrogen, oxygen, or sulfur; each R^2 is independently a hydrocarbyl group having 1 to 9 carbons; each Z is independently nitrogen, oxygen, and/or sulfur; and each R^3 is independently a hydrogen or hydrocarbyl group having 1 to 9 carbons with one or more nitrogen, oxygen, or sulfur functionalization, (e.g., $-NH_2$, $-OH$, etc.) wherein p is 1 to 3, n is 1 to 20 and m is 1 to 3. In some embodiments, X is a cyclic or acyclic alkyl group. In some preferred embodiments, X is aryl moiety. In some embodiments, Y may include one

or more hydrogens. In some preferred embodiments, Z is nitrogen. In some preferred embodiments, Z is oxygen. In some preferred embodiments, Z is oxygen or nitrogen or both.

[019] R¹ is independently a moiety that includes 10 to 400 carbon atoms, such as 10 to 390, 10 to 380, 10 to 370, 10 to 360, 10 to 350, 10 to 340, 10 to 330, 10 to 320, 10 to 310, 10 to 300, 10 to 290, 10 to 280, 10 to 270, 10 to 260, 10 to 250, 10 to 240, 10 to 230, 10 to 220, 10 to 210, 10 to 200, 10 to 190, 10 to 180, 10 to 170, 10 to 160, 10 to 150, 10 to 140, 10 to 130, 10 to 120, 10 to 110, 10 to 100, 10 to 90, 10 to 80, 10 to 70, 10 to 60, 10 to 50, 10 to 40, 10 to 30, 10 to 20, 20 to 400, 20 to 390, 20 to 380, 20 to 370, 20 to 360, 20 to 350, 20 to 340, 20 to 330, 20 to 320, 20 to 310, 20 to 300, 20 to 290, 20 to 280, 20 to 270, 20 to 260, 20 to 250, 20 to 240, 20 to 230, 20 to 220, 20 to 210, 20 to 200, 20 to 190, 20 to 180, 20 to 170, 20 to 160, 20 to 150, 20 to 140, 20 to 130, 20 to 120, 20 to 110, 20 to 100, 20 to 90, 20 to 80, 20 to 70, 20 to 60, 20 to 50, 20 to 40, 20 to 30, 30 to 400, 30 to 390, 30 to 380, 30 to 370, 30 to 360, 30 to 350, 30 to 340, 30 to 330, 30 to 320, 30 to 310, 30 to 300, 30 to 290, 30 to 280, 30 to 270, 30 to 260, 30 to 250, 30 to 240, 30 to 230, 30 to 220, 30 to 210, 30 to 200, 30 to 190, 30 to 180, 30 to 170, 30 to 160, 30 to 150, 30 to 140, 30 to 130, 30 to 120, 30 to 110, 30 to 100, 30 to 90, 30 to 80, 30 to 70, 30 to 60, 30 to 50, 30 to 40, 40 to 400, 40 to 390, 40 to 380, 40 to 370, 40 to 360, 40 to 350, 40 to 340, 40 to 330, 40 to 320, 40 to 310, 40 to 300, 40 to 290, 40 to 280, 40 to 270, 40 to 260, 40 to 250, 40 to 240, 40 to 230, 40 to 220, 40 to 210, 40 to 200, 40 to 190, 40 to 180, 40 to 170, 40 to 160, 40 to 150, 40 to 140, 40 to 130, 40 to 120, 40 to 110, 40 to 100, 40 to 90, 40 to 80, 40 to 70, 40 to 60, 40 to 50, 50 to 400, 50 to 390, 50 to 380, 50 to 370, 50 to 360, 50 to 350, 50 to 340, 50 to 330, 50 to 320, 50 to 310, 50 to 300, 50 to 290, 50 to 280, 50 to 270, 50 to 260, 50 to 250, 50 to 240, 50 to 230, 50 to 220, 50 to 210, 50 to 200, 50 to 190, 50 to 180, 50 to 170, 50 to 160, 50 to 150, 50 to 140, 50 to 130, 50 to 120, 50 to 110, 50 to 100, 50 to 90, 50 to 80, 50 to 70, 50 to 60, 60 to 400, 60 to 390, 60 to 380, 60 to 370, 60 to 360, 60 to 350, 60 to 340, 60 to 330, 60 to 320, 60 to 310, 60 to 300, 60 to 290, 60 to 280, 60 to 270, 60 to 260, 60 to 250, 60 to 240, 60 to 230, 60 to 220, 60 to 210,

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270, 230 to 260, 230 to 250, 230 to 240, 240 to 400, 240 to 390, 240 to 380, 240 to 370, 240 to 360, 240 to 350, 240 to 340, 240 to 330, 240 to 320, 240 to 310, 240 to 300, 240 to 290, 240 to 280, 240 to 270, 240 to 260, 240 to 250, 250 to 400, 250 to 390, 250 to 380, 250 to 370, 250 to 360, 250 to 350, 250 to 340, 250 to 330, 250 to 320, 250 to 310, 250 to 300, 250 to 290, 250 to 280, 250 to 270, 250 to 260, 260 to 400, 260 to 390, 260 to 380, 260 to 370, 260 to 360, 260 to 350, 260 to 340, 260 to 330, 260 to 320, 260 to 310, 260 to 300, 260 to 290, 260 to 280, 260 to 270, 270 to 400, 270 to 390, 270 to 380, 270 to 370, 270 to 360, 270 to 350, 270 to 340, 270 to 330, 270 to 320, 270 to 310, 270 to 300, 270 to 290, 270 to 280, 280 to 400, 280 to 390, 280 to 380, 280 to 370, 280 to 360, 280 to 350, 280 to 340, 280 to 330, 280 to 320, 280 to 310, 280 to 300, 280 to 290, 290 to 400, 290 to 390, 290 to 380, 290 to 370, 290 to 360, 290 to 350, 290 to 340, 290 to 330, 290 to 320, 290 to 310, 290 to 300, 300 to 400, 300 to 390, 300 to 380, 300 to 370, 300 to 360, 300 to 350, 300 to 340, 300 to 330, 300 to 320, 300 to 310, 310 to 400, 310 to 390, 310 to 380, 310 to 370, 310 to 360, 310 to 350, 310 to 340, 310 to 330, 310 to 320, 320 to 400, 320 to 390, 320 to 380, 320 to 370, 320 to 360, 320 to 350, 320 to 340, 320 to 330, 330 to 400, 330 to 390, 330 to 380, 330 to 370, 330 to 360, 330 to 350, 330 to 340, 340 to 400, 340 to 390, 340 to 380, 340 to 370, 340 to 360, 340 to 350, 350 to 400, 350 to 390, 350 to 380, 350 to 370, 350 to 360, 360 to 400, 360 to 390, 360 to 380, 360 to 370, 370 to 400, 370 to 390, 370 to 380, 380 to 400, 380 to 390, or 390 to 400 carbon atoms.

[020] In some embodiments, R^1 may include, for example, saturated and unsaturated hydrocarbon groups, linear and branched alkyl groups, and polyalkyl groups (e.g., polyisobutenyl group or "PIB", polyethylene, polypropylene, etc.). The polyalkyl groups may be the obtained from a polymerization reaction using olefin monomers (e.g., isobutylene).

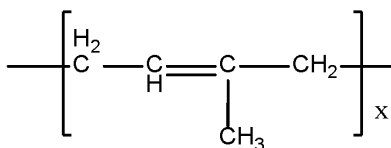
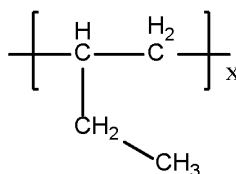
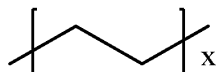
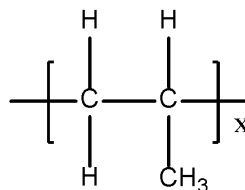
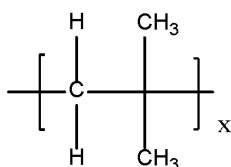
[021] In some preferred embodiments, R^1 is a polyisobutenyl group. In some preferred embodiments, the polyisobutenyl group has an average molecular weight of about 350 to about 5000. In some preferred embodiments, the polyisobutenyl group has an average molecular weight of about 150 to about 1250, such as about 200 to

about 1200, about 300 to about 1100, about 400 to about 1000, about 500 to about 900, and about 600 to about 800. In some preferred embodiments, the polyisobutenyl group has an average molecular weight of about 250 to about 1000, such as about 300 to about 900, about 400 to about 800, and about 500 to about 700.

[022] In some preferred embodiments, the polyisobutenyl group has an average molecular weight of about 500 to about 4000, such as about 600 to about 5000, about 700 to about 5000, about 800 to about 5000, about 900 to about 5000, about 1000 to about 5000, about 500 to about 4000, such as about 600 to about 4000, about 700 to about 4000, about 800 to about 4000, about 900 to about 4000, about 1000 to about 4000, about 1100 to about 4000, about 1200 to about 4000, about 1300 to about 4000, about 1400 to about 4000, about 1500 to about 4000, about 1600 to about 4000, about 1700 to about 4000, about 1800 to about 4000, about 1900 to about 4000, about 2000 to about 4000, about 2100 to about 4000, about 2200 to about 4000, about 2300 to about 4000, about 2400 to about 4000, about 2500 to about 4000, about 2600 to about 4000, about 2700 to about 4000, about 2800 to about 4000, about 2900 to about 4000, about 3000 to about 4000, about 500 to about 3500, such as about 600 to about 3500, about 700 to about 3500, about 800 to about 3500, about 900 to about 3500, about 1000 to about 3500, about 1100 to about 3500, about 1200 to about 3500, about 1300 to about 3500, about 1400 to about 3500, about 1500 to about 3500, about 1600 to about 3500, about 1700 to about 3500, about 1800 to about 3500, about 1900 to about 3500, about 2000 to about 3500, about 2100 to about 3500, about 2200 to about 3500, about 2300 to about 3500, about 2400 to about 3500, about 2500 to about 3500, about 2600 to about 3500, about 2700 to about 3500, about 2800 to about 3500, about 2900 to about 3500, about 3000 to about 3500, about 500 to about 3000, such as about 600 to about 3000, about 700 to about 3000, about 800 to about 3000, about 900 to about 3000, about 1000 to about 3000, about 1100 to about 3000, about 1200 to about 3000, about 1300 to about 3000, about 1400 to about 3000, about 1500 to about 3000, about 1600 to about 3000, about 1700 to about 3000, about 1800 to about 3000, about 1900 to about 3000, about 2000 to about 3000, about 2100 to about 3000,

about 2200 to about 3000, about 2300 to about 3000, about 2400 to about 3000, and about 2500 to about 3000.

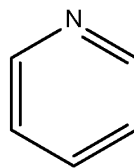
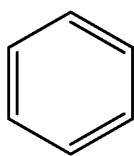
[023] Specific examples of R¹ include the following:

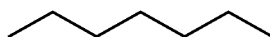
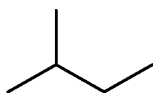
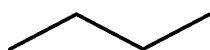
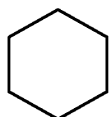
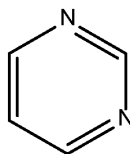
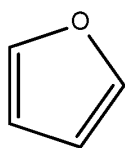


wherein x is an integer such that the total number of carbons is from 10 to 400 as described herein.

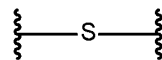
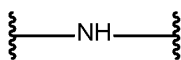
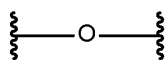
[024] X is a moiety that includes 1 to 10 carbon atoms, such as 1 to 9, 1 to 8, 1 to 7, 1 to 6, 1 to 5, 1 to 4, 1 to 3, 1 to 2, 2 to 10, 2 to 9, 2 to 8, 2 to 7, 2 to 6, 2 to 5, 2 to 4, 2 to 3, 3 to 10, 3 to 9, 3 to 8, 3 to 7, 3 to 6, 3 to 5, 3 to 4, 4 to 10, 4 to 9, 4 to 8, 4 to 7, 4 to 6, 4 to 5, 5 to 10, 5 to 9, 5 to 8, 5 to 7, 5 to 6, 6 to 10, 6 to 9, 6 to 8, 6 to 7, 7 to 10, 7 to 9, 7 to 8, 8 to 10, 8 to 9, or 9 to 10 carbon atoms.

[025] Specific examples of X include the following:





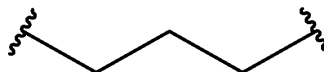
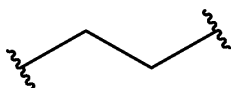
[026] Examples of Y include, for example, the following:

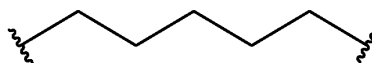
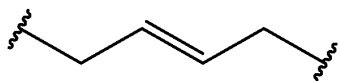
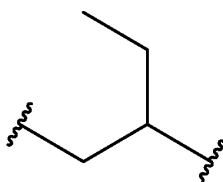


[027] Each R^2 is independently a moiety that includes 1 to 9 carbon atoms, such as from 1 to 8, 1 to 7, 1 to 6, 1 to 5, 1 to 4, 1 to 3, 1 to 2, 2 to 9, 2 to 8, 2 to 7, 2 to 6, 2 to 5, 2 to 4, 2 to 3, 3 to 9, 3 to 7, 3 to 6, 3 to 5, 3 to 4, 4 to 9, 4 to 8, 4 to 7, 4 to 6, 4 to 5, 5 to 9, 5 to 8, 5 to 7, 5 to 6, 6 to 9, 6 to 8, 6 to 7, 7 to 9, 7 to 8, or 8 to 9 carbon atoms.

[028] Suitable examples of R^2 include, for example, saturated and unsaturated hydrocarbon groups, and linear and branched alkyl groups.

[029] Specific examples of R^2 include the following:

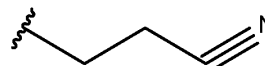
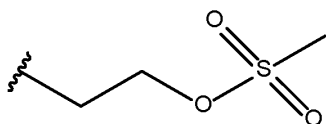
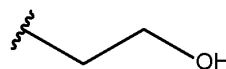
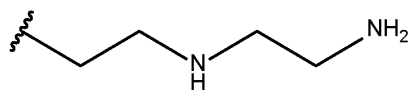
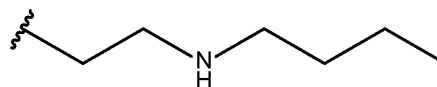
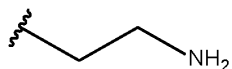


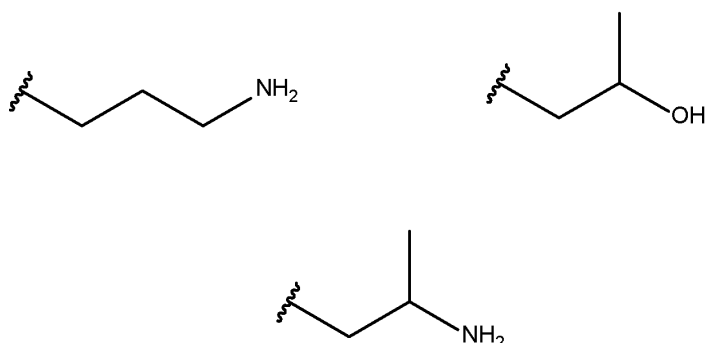


[030] Z is nitrogen, oxygen, or sulfur atom.

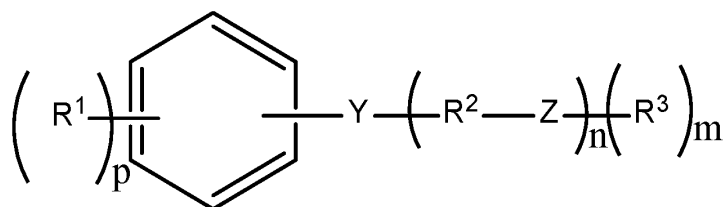
[031] Each R^3 is independently a hydrogen atom or a moiety that includes 1 to 9 carbon atoms, such as from 1 to 8, 1 to 7, 1 to 6, 1 to 5, 1 to 4, 1 to 3, 1 to 2, 2 to 9, 2 to 8, 2, to 7, 2 to 6, 2 to 5, 2 to 4, 2 to 3, 3 to 9, 3 to 7, 3 to 6, 3 to 5, 3 to 4, 4 to 9, 4 to 8, 4 to 7, 4 to 6, 4 to 5, 5 to 9, 5 to 8, 5 to 7, 5 to 6, 6 to 9, 6 to 8, 6 to 7, 7 to 9, 7 to 8, or 8 to 9 carbon atoms. Each R^3 moiety includes one or more nitrogen, oxygen, or sulfur functionalization.

[032] Specific examples of R^3 include the following:





[033] In some preferred embodiments, the lubricant additive may have the following generalized Structure 2:

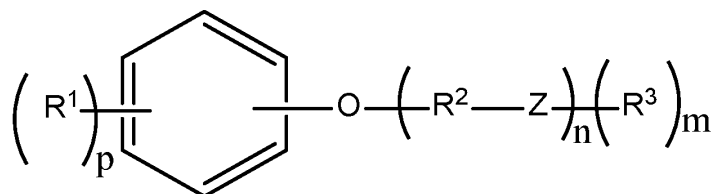


Structure 2

wherein each R^1 is independently a hydrocarbyl group having 10 to 400 carbons; Y is nitrogen, oxygen, or sulfur; each R^2 is independently a hydrocarbyl group having 1 to 9 carbons; each Z is independently nitrogen, oxygen, or sulfur; and each R^3 is independently a hydrogen or hydrocarbyl group having 1 to 9 carbons with one or more nitrogen, oxygen, or sulfur functionalization (e.g., $-NH_2$, $-OH$, etc.), wherein p is 1 to 3, n is 1 to 20 and m is 1 to 3. In some preferred embodiments, Z is nitrogen. In some preferred embodiments, Z is oxygen. In some preferred embodiments, Z is oxygen or nitrogen or both. In some embodiments, Y may include one or more hydrogens.

[034] In some embodiments, Y may include one or more hydrogens.

[035] In some preferred embodiments, the lubricant additive may have the following generalized Structure 3:



Structure 3

wherein each R^1 is independently a hydrocarbyl group having 10 to 400 carbons; each R^2 is independently a hydrocarbyl group having 1 to 6 9 carbons; each Z is independently nitrogen, oxygen, or sulfur; and each R^3 is independently a hydrogen or hydrocarbyl group having 1 to 9 carbons with one or more nitrogen, oxygen, or sulfur functionalization, wherein p is 1 to 3, n is 1 to 20 and m is 1 to 3.

[036] Referring to the generalized structures disclosed herein, R^1 may have 10 to 400 carbon such as 10 to 380 carbons, 10 to 360 carbons, 10 to 340 carbons, 10 to 320 carbons, 10 to 300 carbons, 10 to 280 carbons, 10 to 260 carbons, 10 to 240 carbons, 10 to 220 carbons, 10 to 200 carbons, 10 to 180 carbons, 10 to 160 carbons, 10 to 140 carbons, 10 to 120 carbons, 10 to 100 carbons, 10 to 80 carbons, 10 to 60 carbons, 10 to 40 carbons, 10 to 20 carbons, 50 to 400 carbons, 50 to 380 carbons, 50 to 360 carbons, 50 to 340 carbons, 50 to 320 carbons, 50 to 300 carbons, 50 to 280 carbons, 50 to 260 carbons, 50 to 240 carbons, 50 to 220 carbons, 50 to 200 carbons, 50 to 180 carbons, 50 to 160 carbons, 50 to 140 carbons, 50 to 120 carbons, 50 to 100 carbons, 50 to 80 carbons, 50 to 60 carbon, 100 to 400 carbons, 100 to 380 carbons, 100 to 360 carbons, 100 to 340 carbons, 100 to 320 carbons, 100 to 300 carbons, 100 to 280 carbons, 100 to 260 carbons, 100 to 240 carbons, 100 to 220 carbons, 100 to 200 carbons, 100 to 180 carbons, 100 to 160 carbons, 100 to 140 carbons, 100 to 120 carbons, 150 carbons to 400 carbons, 150 to 380 carbons, 150 to 360 carbons, 150 to 340 carbons, 150 to 320 carbons, 150 to 300 carbons, 150 to 280 carbons, 150 to 260 carbons, 150 to 240 carbons, 150 to 220 carbons, 150 to 200 carbons, 150 to 180

carbons, 150 to 160 carbons, 200 to 400 carbons, 200 to 380 carbons, 200 to 360 carbons, 200 to 340 carbons, 200 to 320 carbons, 200 to 300 carbons, 200 to 280 carbons, 200 to 260 carbons, 200 to 240 carbons, 200 to 220 carbons, 250 to 400 carbons, 250 to 380 carbons, 250 to 360 carbons, 250 to 340 carbons, 250 to 320 carbons, 250 to 300 carbons, 250 to 280 carbons, 250 to 260 carbons, 300 to 400 carbons, 300 to 380 carbons, 300 to 360 carbons, 300 to 340 carbons, 300 to 320 carbons, 350 to 400 carbons, 350 to 380 carbons, or 350 to 360 carbons.

[037] Referring to the generalized structures disclosed herein, X may have 1 to 10 carbons, such as from 1 to 9 carbons, 1 to 8 carbons, 1 to 7 carbons, 1 to 6 carbons, 1 to 5 carbons, 1 to 4 carbons, 1 to 3 carbons, 1 to 2 carbons, 2 to 10 carbons, 2 to 9 carbons, 2 to 8 carbons, 2 to 7 carbons, 2 to 6 carbons, 2 to 5 carbons, 2 to 4 carbons, 2 to 3 carbons, 3 to 10 carbons, 3 to 9 carbons, 3 to 8 carbons, 3 to 7 carbons, 3 to 6 carbons, 3 to 5 carbons, 3 to 4 carbons, 4 to 10 carbons, 4 to 9 carbons, 4 to 8 carbons, 4 to 7 carbons, 4 to 6 carbons, 4 to 5 carbons, 5 to 10 carbons, 5 to 9 carbons, 5 to 8 carbons, 5 to 7 carbons, 5 to 6 carbons, 6 to 10 carbons, 6 to 9 carbons, 6 to 8 carbons, 6 to 7 carbons, 7 to 10 carbons, 7 to 9 carbons, 7 to 8 carbons, 8 to 10 carbons, 8 to 9 carbons, or 9 to 10 carbons.

[038] Referring to the generalized structures disclosed herein, Y may have 1 to 9 carbons, such as 1 to 8 carbons, 1 to 7 carbons, 1 to 6 carbons, 1 to 5 carbons, 1 to 4 carbons, 1 to 3 carbons, 1 to 2 carbons, 2 to 9 carbons, 2 to 8 carbons, 2 to 7 carbons, 2 to 6 carbons, 2 to 5 carbons, 2 to 4 carbons, 2 to 3 carbons, 3 to 9 carbons, 3 to 8 carbons, 3 to 7 carbons, 3 to 6 carbons, 3 to 5 carbons, 3 to 4 carbons, 4 to 9 carbons, 4 to 8 carbons, 4 to 7 carbons, 4 to 6 carbons, 4 to 5 carbons, 5 to 9 carbons, 5 to 8 carbons, 5 to 7 carbons, 5 to 6 carbons, 6 to 9 carbons, 6 to 8 carbons, 6 to 7 carbons, 7 to 9 carbons, 7 to 8 carbons, or 8 to 9 carbons.

[039] Referring to the generalized structures disclosed herein, R¹ may have 1 to 9 carbons, such as 1 to 8 carbons, 1 to 7 carbons, 1 to 6 carbons, 1 to 5 carbons, 1 to 4 carbons, 1 to 3 carbons, 1 to 2 carbons, 2 to 9 carbons, 2 to 8 carbons, 2 to 7 carbons, 2 to 6 carbons, 2 to 5 carbons, 2 to 4 carbons, 2 to 3 carbons, 3 to 9 carbons,

3 to 8 carbons, 3 to 7 carbons, 3 to 6 carbons, 3 to 5 carbons, 3 to 4 carbons, 4 to 9 carbons, 4 to 8 carbons, 4 to 7 carbons, 4 to 6 carbons, 4 to 5 carbons, 5 to 9 carbons, 5 to 8 carbons, 5 to 7 carbons, 5 to 6 carbons, 6 to 9 carbons, 6 to 8 carbons, 6 to 7 carbons, 7 to 9 carbons, 7 to 8 carbons, or 8 to 9 carbons.

[040] Referring to the generalized structures disclosed herein, p is 1 to 3, such as from 1, to 2, or 2 to 3.

[041] Referring to the generalized structures disclosed herein, n is 1 to 20, such as from 1 to 19, 1 to 18, 1 to 17, 1 to 16, 1 to 15, 1 to 14, 1 to 13, 1 to 12, 1 to 11, 1 to 10, 1 to 9, 1 to 8, 1 to 7, 1 to 6, 1 to 5, 1 to 4, 1 to 3, 1 to 2, 2 to 20, 2 to 19, 2 to 18, 2 to 17, 2 to 16, 2 to 15, 2 to 14, 2 to 13, 2 to 12, 2 to 11, 2 to 10, 2 to 9, 2 to 8, 2 to 7, 2 to 6, 2 to 5, 2 to 4, 2 to 3, 3 to 20, 3 to 19, 3 to 18, 3 to 17, 3 to 16, 3 to 15, 3 to 14, 3 to 13, 3 to 12, 3 to 11, 3 to 10, 3 to 9, 3 to 8, 3 to 7, 3 to 6, 3 to 5, 3 to 4, 4 to 20, 4 to 19, 4 to 18, 4 to 17, 4 to 16, 4 to 15, 4 to 14, 4 to 13, 4 to 12, 4 to 11, 4 to 10, 4 to 9, 4 to 8, 4 to 7, 4 to 6, 4 to 5, 5 to 20, 5 to 19, 5 to 18, 5 to 17, 5 to 16, 5 to 15, 5 to 14, 5 to 13, 5 to 12, 5 to 11, 5 to 10, 5 to 9, 5 to 8, 5 to 7, 5 to 6, 6 to 20, 6 to 19, 6 to 18, 6 to 17, 6 to 16, 6 to 15, 6 to 14, 6 to 13, 6 to 12, 6 to 11, 6 to 10, 6 to 9, 6 to 8, 6 to 7, 7 to 20, 7 to 19, 7 to 18, 7 to 17, 7 to 16, 7 to 15, 7 to 14, 7 to 13, 7 to 12, 7 to 11, 7 to 10, 7 to 9, 7 to 8, 8 to 20, 8 to 19, 8 to 18, 8 to 17, 8 to 16, 8 to 15, 8 to 14, 8 to 13, 8 to 12, 8 to 11, 8 to 10, 8 to 9, 9 to 20, 9 to 19, 9 to 18, 9 to 17, 9 to 16, 9 to 15, 9 to 14, 9 to 13, 9 to 12, 9 to 11, 9 to 10, 10 to 20, 10 to 19, 10 to 18, 10 to 17, 10 to 16, 10 to 15, 10 to 14, 10 to 13, 10 to 12, 10 to 11, 11 to 20, 11 to 19, 11 to 18, 11 to 17, 11 to 16, 11 to 15, 11 to 14, 11 to 13, 11 to 12, 12 to 20, 12 to 19, 12 to 18, 12 to 17, 12 to 16, 12 to 15, 12 to 14, 12 to 13, 13 to 20, 13 to 19, 13 to 18, 13 to 17, 13 to 16, 13 to 15, 13 to 14, 14 to 20, 14 to 19, 14 to 18, 14 to 17, 14 to 16, 14 to 15, 15 to 20, 15 to 19, 15 to 18, 15 to 17, 15 to 16, 16 to 20, 16 to 19, 16 to 18, 16 to 17, 17 to 20, 17 to 19, 17 to 18, 18 to 20, 18 to 19, or 19 to 20.

[042] Referring to the generalized structures disclosed herein, m is 1 to 3, such as from 1, to 2, or 2 to 3.

[043] All concentrations of materials disclosed in this application, unless otherwise specified, are on an "actives" basis; that is, the concentrations reported do not include, e.g., diluent or unreacted starting materials or intermediates.

[044] When formulated in engine oil (i.e., lubricating oil composition), used in an engine flush process as part of an aftermarket additive package, or used during a rapid cleaning service, the additive composition is usually present in concentrations ranging from about 0.1 to about 50.0 wt. % based on total weight of the lubricating oil composition (can be the mixed product), such as about 1 wt. % to about 50 wt. %, about 5 wt. % to about 50 wt. %, about 10 wt. % to about 50 wt. %, about 15 wt. % to about 50 wt. %, about 20 wt. % to about 50 wt. %, about 25 wt. % to about 50 wt. %, about 30 wt. % to about 50 wt. %, about 35 wt. % to about 50 wt. %, about 40 wt. % to about 50 wt. %, about 45 wt. % to about 50 wt. %, about 0.1 wt. % to about 45 wt. %, about 1 wt. % to about 45 wt. %, about 5 wt. % to about 45 wt. %, about 10 wt. % to about 45 wt. %, about 15 wt. % to about 45 wt. %, about 20 wt. % to about 45 wt. %, about 25 wt. % to about 45 wt. %, about 30 wt. % to about 45 wt. %, about 35 wt. % to about 45 wt. %, about 40 wt. % to about 45 wt. %, about 0.1 wt. % to about 40 wt. %, about 1 wt. % to about 40 wt. %, about 5 wt. % to about 40 wt. %, about 10 wt. % to about 40 wt. %, about 15 wt. % to about 40 wt. %, about 20 wt. % to about 40 wt. %, about 25 wt. % to about 40 wt. %, about 30 wt. % to about 40 wt. %, about 35 wt. % to about 40 wt. %, about 0.1 wt. % to about 35 wt. %, about 1 wt. % to about 35 wt. %, about 5 wt. % to about 35 wt. %, about 10 wt. % to about 35 wt. %, about 15 wt. % to about 35 wt. %, about 20 wt. % to about 35 wt. %, about 25 wt. % to about 35 wt. %, about 30 wt. % to about 35 wt. %, about 0.1 wt. % to about 30 wt. %, about 1 wt. % to about 30 wt. %, about 5 wt. % to about 30 wt. %, about 10 wt. % to about 30 wt. %, about 15 wt. % to about 30 wt. %, about 20 wt. % to about 30 wt. %, about 25 wt. % to about 30 wt. %, about 0.1 wt. % to about 25 wt. %, about 1 wt. % to about 25 wt. %, about 5 wt. % to about 25 wt. %, about 10 wt. % to about 25 wt. %, about 15 wt. % to about 25 wt. %, and about 20 wt. % to about 25 wt. %, about 0.1 wt. % to about 20.0 wt. %, about 0.1 wt. % to about 19.0 wt. %, about 0.1 wt. % to about 18.0 wt. %, about

0.1 wt. % to about 17.0 wt. %, about 0.1 wt. % to about 16.0 wt. %, about 0.1 wt. % to about 15.0 wt. %, about 0.1 wt. % to about 14.0 wt. %, about 0.1 wt. % to about 13.0 wt. %, about 0.1 wt. % to about 12.0 wt. %, about 0.1 wt. % to about 11.0 wt. %, about 0.1 wt. % to about 10.0 wt. %, about 0.1 wt. % to about 9.0 wt. %, about 0.1 wt. % to about 8.0 wt. %, about 0.1 wt. % to about 7.0 wt. %, about 0.1 wt. % to about 6.0 wt. %, about 0.1 wt. % to about 5.0 wt. %, about 0.1 wt. % to about 4.0 wt. %, about 0.1 wt. % to about 3.0 wt. %, about 0.1 wt. % to about 2.0 wt. %, about 0.1 wt. % to about 1.0 wt. %, about 1.0 wt. % to about 20.0 wt. %, about 1.0 wt. % to about 19.0 wt. %, about 1.0 wt. % to about 18.0 wt. %, about 1.0 wt. % to about 17.0 wt. %, about 1.0 wt. % to about 16.0 wt. %, about 1.0 wt. % to about 15.0 wt. %, about 1.0 wt. % to about 14.0 wt. %, about 1.0 wt. % to about 13.0 wt. %, about 1.0 wt. % to about 12.0 wt. %, about 1.0 wt. % to about 11.0 wt. %, about 1.0 wt. % to about 10.0 wt. %, about 1.0 wt. % to about 9.0 wt. %, about 1.0 wt. % to about 8.0 wt. %, about 1.0 wt. % to about 7.0 wt. %, about 1.0 wt. % to about 6.0 wt. %, about 1.0 wt. % to about 5.0 wt. %, about 1.0 wt. % to about 4.0 wt. %, about 1.0 wt. % to about 3.0 wt. %, about 1.0 wt. % to about 2.0 wt. %, about 2.0 wt. % to about 20.0 wt. %, about 2.0 wt. % to about 19.0 wt. %, about 2.0 wt. % to about 18.0 wt. %, about 2.0 wt. % to about 17.0 wt. %, about 2.0 wt. % to about 16.0 wt. %, about 2.0 wt. % to about 15.0 wt. %, about 2.0 wt. % to about 14.0 wt. %, about 2.0 wt. % to about 13.0 wt. %, about 2.0 wt. % to about 12.0 wt. %, about 2.0 wt. % to about 11.0 wt. %, about 2.0 wt. % to about 10.0 wt. %, about 2.0 wt. % to about 9.0 wt. %, about 2.0 wt. % to about 8.0 wt. %, about 2.0 wt. % to about 7.0 wt. %, about 2.0 wt. % to about 6.0 wt. %, about 2.0 wt. % to about 5.0 wt. %, about 2.0 wt. % to about 4.0 wt. %, about 2.0 wt. % to about 3.0 wt. %, about 3.0 wt. % to about 20.0 wt. %, about 3.0 wt. % to about 19.0 wt. %, about 3.0 wt. % to about 18.0 wt. %, about 3.0 wt. % to about 17.0 wt. %, about 3.0 wt. % to about 16.0 wt. %, about 3.0 wt. % to about 15.0 wt. %, about 3.0 wt. % to about 14.0 wt. %, about 3.0 wt. % to about 13.0 wt. %, about 3.0 wt. % to about 12.0 wt. %, about 3.0 wt. % to about 11.0 wt. %, about 3.0 wt. % to about 10.0 wt. %, about 3.0 wt. % to about 9.0 wt. %, about 3.0 wt. % to about 8.0 wt. %, about 3.0 wt. % to about 7.0 wt. %, about 3.0 wt. % to about 6.0 wt. %.

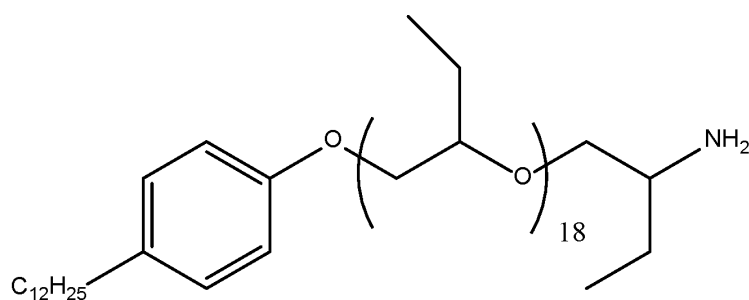
%, about 3.0 wt. % to about 5.0 wt. %, about 3.0 wt. % to about 4.0 wt. %, about 4.0 wt. % to about 20.0 wt. %, about 5.0 wt. % to about 20.0 wt. %, about 5.0 wt. % to about 19.0 wt. %, about 5.0 wt. % to about 18.0 wt. %, about 5.0 wt. % to about 17.0 wt. %, about 5.0 wt. % to about 16.0 wt. %, about 5.0 wt. % to about 15.0 wt. %, about 5.0 wt. % to about 14.0 wt. %, about 5.0 wt. % to about 13.0 wt. %, about 5.0 wt. % to about 12.0 wt. %, about 5.0 wt. % to about 11.0 wt. %, about 5.0 wt. % to about 10.0 wt. %, about 5.0 wt. % to about 9.0 wt. %, about 5.0 wt. % to about 8.0 wt. %, about 5.0 wt. % to about 7.0 wt. %, about 5.0 wt. % to about 6.0 wt. %, about 6.0 wt. % to about 20.0 wt. %, about 6.0 wt. % to about 19.0 wt. %, about 6.0 wt. % to about 18.0 wt. %, about 6.0 wt. % to about 17.0 wt. %, about 6.0 wt. % to about 16.0 wt. %, about 6.0 wt. % to about 15.0 wt. %, about 6.0 wt. % to about 14.0 wt. %, about 6.0 wt. % to about 13.0 wt. %, about 6.0 wt. % to about 12.0 wt. %, about 6.0 wt. % to about 11.0 wt. %, about 6.0 wt. % to about 10.0 wt. %, about 6.0 wt. % to about 9.0 wt. %, about 6.0 wt. % to about 8.0 wt. %, about 6.0 wt. % to about 7.0 wt. %, about 7.0 wt. % to about 20.0 wt. %, about 7.0 wt. % to about 19.0 wt. %, about 7.0 wt. % to about 18.0 wt. %, about 7.0 wt. % to about 17.0 wt. %, about 7.0 wt. % to about 16.0 wt. %, about 7.0 wt. %, to about 15.0 wt. %, about 7.0 wt. % to about 14.0 wt. %, about 7.0 wt. % to about 13.0 wt. %, about 7.0 wt. % to about 12.0 wt. %, about 7.0 wt. % to about 11.0 wt. %, about 7.0 wt. % to about 10.0 wt. %, about 7.0 wt. % to about 9.0 wt. %, about 7.0 wt. % to about 8.0 wt. %, about 8.0 wt. % to about 20.0 wt. %, about 8.0 wt. % to about 19.0 wt. %, about 8.0 wt. % to about 18.0 wt. %, about 8.0 wt. % to about 17.0 wt. %, about 8.0 wt. % to about 16.0 wt. %, about 8.0 wt. % to about 15.0 wt. %, about 8.0 wt. % to about 14.0 wt. %, about 8.0 wt. % to about 13.0 wt. %, about 8.0 wt. % to about 12.0 wt. %, about 8.0 wt. % to about 11.0 wt. %, about 8.0 wt. % to about 10.0 wt. %, about 8.0 wt. % to about 9.0 wt. %, about 9.0 wt. % to about 20.0 wt. %, about 9.0 wt. % to about 19.0 wt. %, about 9.0 wt. % to about 18.0 wt. %, about 9.0 wt. % to about 17.0 wt. %, about 9.0 wt. % to about 16.0 wt. %, about 9.0 wt. % to about 15.0 wt. %, about 9.0 wt. % to about 14.0 wt. %, about 9.0 wt. % to about 13.0 wt. %, about 9.0 wt. % to about 12.0 wt. %, about 9.0 wt. % to about 11.0 wt. %, about 9.0 wt. % to about 10.0

wt. %, about 10.0 wt. % to about 20.0 wt. %, about 10.0 wt. % to about 19.0 wt. %, about 10.0 wt. % to about 18.0 wt. %, about 10.0 wt. % to about 17.0 wt. %, about 10.0 wt. % to about 16.0 wt. %, about 10.0 wt. % to about 15.0 wt. %, about 10.0 wt. % to about 14.0 wt. %, about 10.0 wt. % to about 13.0 wt. %, about 10.0 wt. % to about 12.0 wt. %, about 10.0 wt. % to about 11.0 wt. %, about 11.0 wt. % to about 20.0 wt. %, about 11.0 wt. % to about 19.0 wt. %, about 11.0 wt. % to about 18.0 wt. %, about 11.0 wt. % to about 17.0 wt. %, about 11.0 wt. % to about 16.0 wt. %, about 11.0 wt. % to about 15.0 wt. %, about 11.0 wt. % to about 14.0 wt. %, about 11.0 wt. % to about 13.0 wt. %, about 11.0 wt. % to about 12.0 wt. %, about 12.0 wt. % to about 20.0 wt. %, about 12.0 wt. % to about 19.0 wt. %, about 12.0 wt. % to about 18.0 wt. %, about 12.0 wt. % to about 17.0 wt. %, about 12.0 wt. % to about 16.0 wt. %, about 12.0 wt. % to about 15.0 wt. %, about 12.0 wt. % to about 14.0 wt. %, about 12.0 wt. % to about 13.0 wt. %, about 13.0 wt. % to about 20.0 wt. %, about 13.0 wt. % to about 19.0 wt. %, about 13.0 wt. % to about 18.0 wt. %, about 13.0 wt. % to about 17.0 wt. %, about 13.0 wt. % to about 16.0 wt. %, about 13.0 wt. % to about 15.0 wt. %, about 13.0 wt. % to about 14.0 wt. %, about 14.0 wt. % to about 20.0 wt. %, about 14.0 wt. % to about 19.0 wt. %, about 14.0 wt. % to about 18.0 wt. %, about 14.0 wt. % to about 17.0 wt. %, about 14.0 wt. % to about 16.0 wt. %, about 14.0 wt. % to about 15.0 wt. %, about 15.0 wt. % to about 20.0 wt. %, about 15.0 wt. % to about 19.0 wt. %, about 15.0 wt. % to about 18.0 wt. %, about 15.0 wt. % to about 17.0 wt. %, about 15.0 wt. % to about 16.0 wt. %, about 16.0 wt. % to about 20.0 wt. %, about 16.0 wt. % to about 19.0 wt. %, about 16.0 wt. % to about 18.0 wt. %, about 16.0 wt. % to about 17.0 wt. %, about 17.0 wt. % to about 20.0 wt. %, about 17.0 wt. % to about 19.0 wt. %, about 17.0 wt. % to about 18.0 wt. %, about 18.0 wt. % to about 20.0 wt. %, about 18.0 wt. % to about 19.0 wt. %, or about 19.0 wt. % to about 20.0 wt. %.

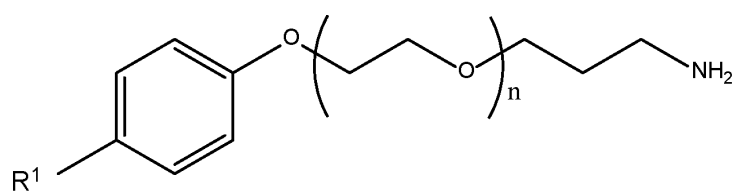
[045] In some embodiments, the additive is present in about 0.1 wt. % to about 4.5 wt. % based on the total weight of the lubricating oil composition, such as about 0.5 wt. % to about 4.0 wt. %, about 0.5 wt. % to about 3.5 wt. %, about 0.5 wt. % to about 3.0 wt. %, about 0.5 wt. % to about 2.5 wt. %, about 0.5 wt. % to about 2.0 wt. %.

%, about 0.5 wt. % to about 1.5 wt. %, about 0.5 wt. % to about 1.0 wt. %, about 1.0 wt. % to about 5.0 wt. %, about 1.0 wt. % to about 4.5 wt. %, about 1.0 wt. % to about 4.0 wt. %, about 1.0 wt. % to about 3.5 wt. %, about 1.0 wt. % to about 3.0 wt. %, about 1.0 wt. % to about 2.5 wt. %, about 1.0 wt. % to about 2.0 wt. %, about 1.0 wt. % to about 1.5 wt. %, about 1.5 wt. %, to about 5.0 wt. %, about 1.5 wt. % to about 4.5 wt. %, about 1.5 wt. % to about 4.0 wt. %, about 1.5 wt. % to about 3.5 wt. %, about 1.5 wt. % to about 3.0 wt. %, about 1.5 wt. % to about 2.5 wt. %, about 1.5 wt. % to about 2.0 wt. %, about 2.0 wt. % to about 5.0 wt. %, about 2.0 wt. % to about 4.5 wt. %, about 2.0 wt. % to about 4.0 wt. %, about 2.0 wt. % to about 3.5 wt. %, about 2.0 wt. % to about 3.0 wt. %, about 2.0 wt. % to about 2.5 wt. %, about 2.5 wt. % to about 5.0 wt. %, about 2.5 wt. % to about 4.5 wt. %, about 2.5 wt. % to about 4.0 wt. %, about 2.5 wt. % to about 3.5 wt. %, about 2.5 wt. % to about 3.0 wt. %, about 3.0 wt. % to about 5.0 wt. %, about 3.0 wt. % to about 4.5 wt. %, about 3.0 wt. % to about 4.0 wt. %, about 3.0 wt. % to about 3.5 wt. %, about 3.5 wt. % to about 5.0 wt. %, about 3.5 wt. % to about 4.5 wt. %, about 3.5 wt. % to about 4.0 wt. %, about 4.0 wt. % to about 5.0 wt. %, about 4.0 wt. % to about 4.5 wt. %, or about 4.5 wt. % to about 5.0 wt. %.

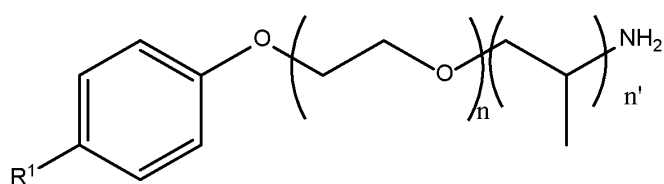
[046] Specific non-limiting examples of the lubricant additive composition include the following:



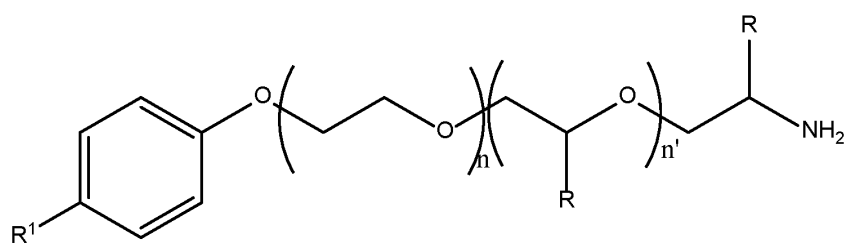
Compound 1

 $n = 1 \text{ to } 6$

Compound 2

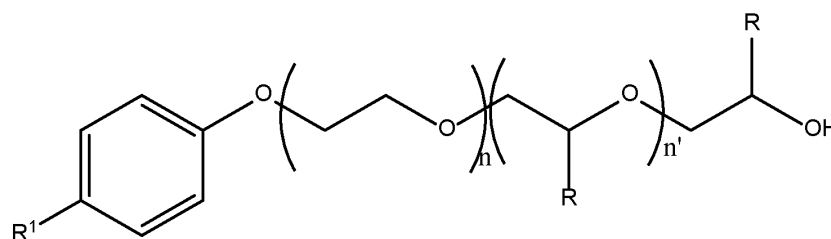


Compound 3

 $n = 0 \text{ to } 3$ $n' = 0 \text{ to } 3$ $n + n' \geq 1$ 

Compound 4

 $n = 0 \text{ to } 3$ $n' = 0 \text{ to } 3$ $n + n' \geq 1$ $\text{R} = \text{H methyl ethyl}$



Compound 5

 $n = 0 \text{ to } 3$ $n' = 0 \text{ to } 3$ $n + n' \geq 1$

R = H methyl ethyl

Synthesis

[047] The lubricant additive composition may be synthesized by any compatible method.

[048] Other derivatization reactions may also be contemplated such between any of the lubricant additive compounds and a suitable reagent such as ethylene oxide, propylene oxide, butylene oxide, vinyl oxirane, diglycidyl ether, acrylonitrile, ammonia, and the like.

Lubricating Oil

[049] The lubricating oil composition of the present invention includes one or more base oils. These include, for example, Group I, II, III, IV, or V base oils, and biobased base oils. Examples of suitable biobased base oils are described in U.S. Patent Pub No. 20230167378, which is hereby incorporated by reference.

[050] Base stocks may be manufactured using a variety of different processes including, but not limited to, distillation, solvent refining, hydrogen processing, oligomerization, esterification, and rerefining. Rerefined stock shall be substantially free from materials introduced through manufacturing, contamination, or previous use. The base oil of the lubricating oil compositions of this invention may be any natural or synthetic lubricating base oil. Suitable hydrocarbon synthetic oils include, but are not limited to, oils prepared from the polymerization of ethylene or from the

polymerization of 1-olefins to provide polymers such as polyalphaolefin or PAO oils, or from hydrocarbon synthesis procedures using carbon monoxide and hydrogen gases such as in a Fischer-Tropsch process.

[051] Moreover, the one or more base oils may include base oils from the same group (e.g., Group II Chevron Neutral Oil 600R®, Group II Chevron Neutral Oil 220R® and Group II Chevron Neutral Oil 100R®). The amount of base oil(s) is about 50 wt. % or greater ("major amount") based on the total weight of the lubricating oil composition.

[052] 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.

[053] 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, e.g. a lubricating oil composition having an Society of Automotive Engineers (SAE). 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 viscosity grade SAE of 0W-20, 0W-26, 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, or 15W-40.

[054] 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," December 2016). 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.

[055] 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.

[056] 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.

[057] 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.

[058] 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 isomerate/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.

[059] 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.

[060] In some embodiments, the lubricating oil composition may have a high temperature shear (HTHS) viscosity at 150° C of at least 2.6 cP, such as at least 2.7 cP, at least 2.8 cP, or at least 2.9 cP.

[061] Typically, the base oil or combination of base oils may have a kinematic viscosity at 100°C (ASTM D445) in a range of 2.5 to 50 mm²/s, such as 2.5 to 50 mm²/s, 2.5 to 45 mm²/s, 2.5 to 40 mm²/s, 2.5 to 35 mm²/s, 2.5 to 30 mm²/s, 2.5 to 25 mm²/s, 2.5 to 20 mm²/s, 2.5 to 15 mm²/s, 2.5 to 12 mm²/s, 2.5 to 11 mm²/s, 2.5 to 10 mm²/s, 2.5 to 9 mm²/s, 2.5 to 8 mm²/s, 2.5 to 7 mm²/s, 2.5 to 6 mm²/s, 2.5 to 5 mm²/s, 2.5 to 4 mm²/s, 3 to 45 mm²/s, 3 to 40 , 3 to 35, 3 to 30, 3 to 25, 3 to 20 , 3 to 15, 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 50 mm²/s, 4 to 45 mm²/s, 4 to 40 mm²/s, 4 to 35 mm²/s, 4 to 30 mm²/s, 4 to 25 mm²/s, 4 to 20 mm²/s, 4 to 15 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 50 mm²/s, 5 to 45 mm²/s, 5 to 40 mm²/s, 5 to 35 mm²/s, 5 to 30 mm²/s, 5 to 25 mm²/s, 5 to 20 mm²/s, 5 to 15 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 50 mm²/s, 6 to 45 mm²/s, 6 to 40 mm²/s, 6 to 35 mm²/s, 6 to 30 mm²/s, 6 to 25 mm²/s, 6 to 20 mm²/s, 6 to 15 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 50 mm²/s, 7 to 45 mm²/s, 7 to 40 mm²/s, 7 to 35 mm²/s, 7 to 30 mm²/s, 7 to 25 mm²/s, 7 to 20 mm²/s, 7 to 15 mm²/s, 7 to 12 mm²/s, 7 to 11 mm²/s, 7 to 10 mm²/s, 7 to 9 mm²/s, 7 to 8 mm²/s, 8 to 50 mm²/s, 8 to 45 mm²/s, 8 to 40 mm²/s, 8 to 35 mm²/s, 8 to 30 mm²/s, 8 to 25 mm²/s, 8 to 20 mm²/s, 8 to 15 mm²/s, 8 to 12 mm²/s, 8 to 11 mm²/s, 8 to 10 mm²/s, 8 to 9 mm²/s, 9

to 50 mm²/s, 9 to 45 mm²/s, 9 to 40 mm²/s, 9 to 35 mm²/s, 9 to 30 mm²/s, 9 to 25 mm²/s, 9 to 20 mm²/s, 9 to 15 mm²/s, 9 to 12 mm²/s, 9 to 11 mm²/s, 9 to 10 mm²/s, 10 to 50 mm²/s, 10 to 45 mm²/s, 10 to 40 mm²/s, 10 to 35 mm²/s, 10 to 30 mm²/s, 10 to 25 mm²/s, 10 to 20 mm²/s, 10 to 15 mm²/s, 10 to 12 mm²/s, 10 to 11 mm²/s, 11 to 50 mm²/s, 11 to 45 mm²/s, 11 to 40 mm²/s, 11 to 35 mm²/s, 11 to 30 mm²/s, 11 to 25 mm²/s, 11 to 20 mm²/s, 11 to 15 mm²/s, or 11 to 12 mm²/s.

Other Additives

[062] The present lubricating oil compositions may also contain conventional 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 antioxidants, ashless dispersants, anti-wear agents, detergents such as metal detergents, rust inhibitors, dehazing agents, demulsifying agents, friction modifiers, metal deactivating agents, pour point depressants, viscosity modifiers, antifoaming agents, co-solvents, package compatibilizers, corrosion-inhibitors, 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.

[063] 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. %.

Formulation

[064] In general, the level of sulfur in the lubricating oil compositions of the present invention is less than or equal to about 0.7 wt. %, based on the total weight of the lubricating oil composition, e.g., a level of sulfur of about 0.01 wt. % to about 0.70

wt. %, 0.01 to 0.6 wt. %, 0.01 to 0.5 wt. %, 0.01 to 0.4 wt. %, 0.01 to 0.3 wt. %, 0.01 to 0.2 wt. %, 0.01 wt. % to 0.10 wt. %. In one embodiment, the level of sulfur in the lubricating oil compositions of the present invention is less than or equal to about 0.60 wt. %, less than or equal to about 0.50 wt. %, less than or equal to about 0.40 wt. %, less than or equal to about 0.30 wt. %, less than or equal to about 0.20 wt. %, less than or equal to about 0.10 wt. % based on the total weight of the lubricating oil composition.

[065] In one embodiment, the levels of phosphorus in the lubricating oil compositions of the present invention is less than or equal to about 0.06 wt.% to about 0.12 wt. %, based on the total weight of the lubricating oil composition, such as 0.06 wt.% to 0.11 wt.%, 0.06 wt.% to 0.10 wt.%, 0.00 wt.% to 0.09 wt.%, 0.06 wt.% to 0.08 wt.%, 0.06 wt.% to 0.07 wt.%, 0.07 wt.% to 0.12 wt.%, 0.07 wt.% to 0.11 wt.%, 0.07 wt.% to 0.10 wt.%, 0.07 wt.% to 0.09 wt.%, 0.07 wt.% to 0.08 wt.%, 0.08 wt.% to 0.12 wt.%, 0.08 wt.% to 0.11 wt.%, 0.08 wt.% to 0.10 wt.%, 0.08 wt.% to 0.09 wt.%, 0.09 wt.% to 0.12 wt.%, 0.09 wt.% to 0.11 wt.%, 0.09 wt.% to 0.10 wt.%, 0.10 wt.% to 0.12 wt.%, 0.10 wt.% to 0.11 wt.%, or 0.11 wt.% to 0.12 wt.%.

[066] In one embodiment, the level of sulfated ash produced by the lubricating oil compositions of the present invention is from about 0.80 wt.% to about 1.60 wt. % as determined by ASTM D 874, such as from 0.80 wt.% to 1.50 wt.%, 0.80 wt.% to about 1.40 wt.%, 0.80 wt.% to 1.30 wt.%, 0.80 wt.% to 1.20 wt.%, 0.80 wt.% to 1.10 wt.%, 0.80 wt.% to 1.00 wt.%, 0.80 wt.% to 0.90 wt.%, 0.90 wt.% to 1.60 wt.%, 0.90 wt.% to 1.50 wt.%, 0.90 wt.% to 1.40 wt.%, 0.90 wt.% to 1.30 wt.%, 0.90 wt.% to 1.20 wt.%, 0.90 wt.% to 1.10 wt.%, 0.90 wt.% to 1.00 wt.%, 1.00 wt.% to 1.60 wt.%, 1.00 wt.% to 1.50 wt.%, 1.00 wt.% to 1.40 wt.%, 1.00 wt.% to 1.30 wt.%, 1.00 wt.% to 1.20 wt.%, 1.00 wt.% to 1.10 wt.%, 1.10 wt.% to 1.60 wt.%, 1.10 wt.% to 1.50 wt.%, 1.10 wt.% to 1.40 wt.%, 1.10 wt.% to 1.30 wt.%, 1.10 wt.% to 1.20 wt.%, 1.20 wt.% to 1.60 wt.%, 1.20 wt.% to 1.50 wt.%, 1.20 wt.% to 1.40 wt.%, 1.20 wt.% to 1.30 wt.%, 1.30 wt.% to 1.60 wt.%, 1.30 wt.% to 1.50 wt.%, 1.30 wt.% to 1.40 wt.%, 1.40 wt.% to 1.60 wt.%, 1.40 wt.% to 1.50 wt.%, or 1.50 wt.% to 1.60 wt.%.

[067] Suitably, the present lubricating oil composition may have a total base number (TBN) of 4 to 15 mg KOH/g (e.g., 5 to 12 mg KOH/g, 6 to 12 mg KOH/g, or 8 to 12 mg KOH/g).

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

EXAMPLES

Baseline Formulation

[069] Baseline Formulation is SAE 5W-40 viscosity grade lubricating oil composition prepared by blending the following components:

- a) borated Ca sulfonate
- b) overbased Ca phenate
- c) ZnDTP
- d) overbased Ca sulfonate
- e) antioxidants
- f) ethylene-propylene viscosity modifier

[070] The remainder of the lubricating oil composition includes a minor amount of foam inhibitor, pour point depressant, and a mixture of Group III base oil with a KV100 of 4 cSt and Group III base oil with KV 100 of 6 cSt.

Comparative Example 1

[071] The following components were added to Baseline Formulation to produce Comparative Example 1:

4.6 wt% of EC-treated succinimide

Inventive Example 1

[072] The following components were added to Baseline Formulation to produce Inventive Example 2:

3.4 wt% of EC-treated succinimide

1.9 wt% of Compound 1

Pressure Differential Scanning Calorimetry (PDSC) Test

[073] In the PDSC Test, the oxidation stability of test oils is measured by detecting the exothermic release of energy that occurs when oils succumb to auto-oxidation. Test oils are held 180° C. under 500 psi of oxygen pressure. The length of time required to reach auto-oxidation is a measure of oxidation resistance and is known as oxidation induction time.

[074] A small quantity of test oil was weighed into a sample pan and placed in a test cell. The cell was heated to a specified temperature and then pressurized with oxygen. The cell was held at a regulated temperature and pressure until an exothermic reaction occurs. The extrapolated onset time as measured and reported as the oxidation induction time for the lubricating oil at the specified test temperature.

TEOST MHT4 TEST

[075] TEOST MH4 Test is designed to predict the deposit-forming tendencies of engine oils in the piston ring belt and upper piston crown area. This test determines the mass of deposit formed on a specially constructed test rod exposed to repetitive passage of 8.5 g of engine oil over the rod in a thin film under oxidative and catalytic conditions at 285 °C.

[076] Deposit-forming tendencies of an engine oil under oxidative conditions as determined by circulating an oil-catalyst mixture comprising a small sample (8.4 g) of the oil and a very small (0.1 g) amount of an organo-metallic catalyst. This mixture was circulated for 24 hours in the TEOST MHT instrument over a special wire-wound depositor rod heated by electrical current to a controlled temperature of 285 °C at the hottest location on the rod. The rod was weighed before and after the test. Deposit that fell off the depositor rod into the oil was filtered and weighed. Total deposit was calculated as the sum of the weight of deposits on depositor rod and on the filter.

Table 1

	Comparative Example 1	Inventive Example 1
PDSC 180 min (Time to Oxidation)	130.6	139.4
TEOST MH4 (mg)	30.7	26.2

2nd Baseline Formulation

[077] The second baseline Formulation is SAE 5W-30 viscosity grade lubricating oil composition prepared by blending the following components:

- a) borated Ca sulfonate
- b) overbased Ca phenate
- c) ZnDTP
- d) overbased Ca sulfonate
- e) antioxidants
- f) foam inhibitor and pour point depressant
- g) ethylene-propylene viscosity modifier

Comparative Example 2

[078] The following components were added to second Baseline Formulation to produce Comparative Example 2:

6 wt% of EC-treated succinimide + 2 wt% base oil

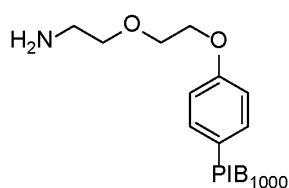
Inventive Example 2

[079] The following components were added to the second Baseline

Formulation to produce Inventive Example 2:

6 wt% of EC-treated succinimide

2 wt% of Compound below:

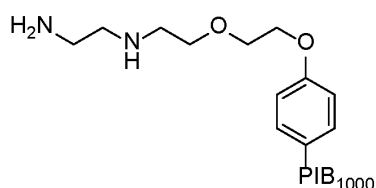
Inventive Example 3

[080] The following components were added to second Baseline Formulation

to produce Inventive Example 3:

6 wt% of EC-treated succinimide

2 wt% of Compound below:



[081] Lubricating oil samples were formulated and tested for oxidation performance via Oxidation Deposit Test (ODT). ODT is a deposit bench test that generates deposits by splashing heated oil onto a heated metal plate for at a specified

interval and duration. The test is described in greater detail in US Pat. No. 8,549,897, which is hereby incorporated by reference.

	ODT (mg)
Comp Ex 2	8
Inv Ex 2	5.5
Inv Ex 3	4.6

[082] 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.

[083] 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.

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

[085] 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.

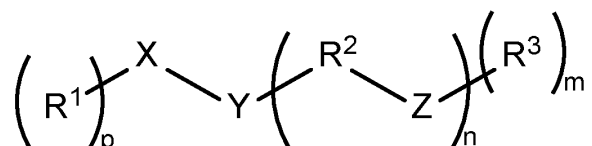
[086] The foregoing description of the disclosure illustrates and describes the present disclosure. Additionally, the disclosure shows and describes only the preferred embodiments but, as mentioned above, it is to be understood that the disclosure is capable of use in various other combinations, modifications, 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.

[087] 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.

[088] 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

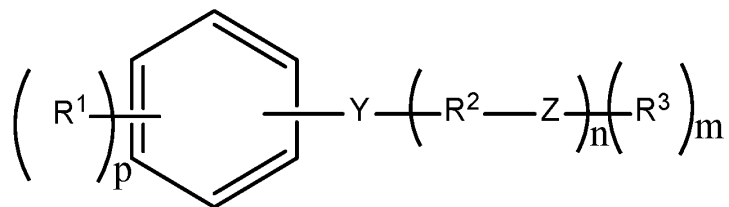
1. A lubricating oil composition comprising:
a major amount of base oil; and
a lubricant additive having the following structure:



wherein each R^1 is independently a hydrocarbyl group having 10 to 400 carbons; X is an alkyl, aryl, or heteroaromatic group having 1 to 10 carbons; Y is nitrogen, oxygen, or sulfur; each R^2 is independently a hydrocarbyl group having 1 to 9 carbons; each Z is nitrogen, oxygen, or sulfur; and each R^3 is independently a hydrogen or hydrocarbyl group having 1 to 9 carbons with one or more nitrogen, oxygen, or sulfur functionalization, wherein p is 1 to 3, n is 1 to 20, and m is 1 to 3.

2. The lubricating oil composition of claim 1, wherein the lubricant additive is present in about 0.1 to about 50.0 wt. % based on total weight of the lubricating oil composition.
3. The lubricating oil composition of claim 1, wherein R^1 is a polyalkyl group.
4. The lubricating oil composition of claim 1, wherein R^1 is a polyisobutenyl group.
5. The lubricating oil composition of claim 1, further comprising a succinimide dispersant.
6. The lubricating composition of claim 1, wherein the lubricant additive is present in about 0.1 to about 50.0 wt. % based on total weight of the lubricating oil composition.

7. The lubricating oil composition of claim 1, wherein the lubricant additive has the following generalized structure:

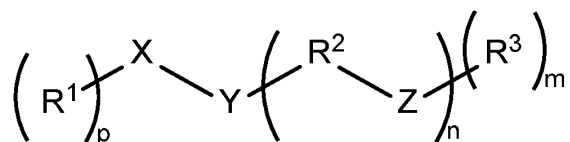


wherein each R^1 is independently a hydrocarbyl group having 10 to 400 carbons; Y is nitrogen, oxygen, or sulfur; each R^2 is independently a hydrocarbyl group having 1 to 9 carbons; each Z is nitrogen, oxygen, or sulfur; and each R^3 is independently a hydrogen or hydrocarbyl group having 1 to 6 carbons with one or more nitrogen, oxygen, or sulfur functionalization, wherein p is 1 to 3, n is 1 to 20, and m is 1 to 3.

8. A method of lubricating an engine, the method comprising lubricating the engine with a lubricating oil composition comprising:

a major amount of base oil; and

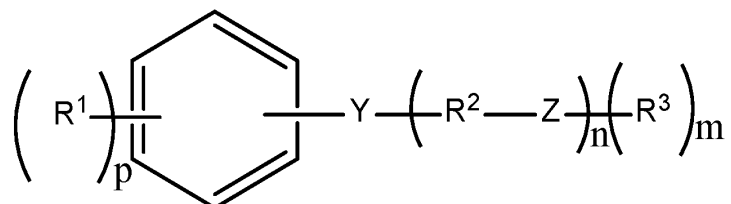
a lubricant additive having the following structure:



wherein each R^1 is independently a hydrocarbyl group having 10 to 400 carbons; X is an alkyl, aryl, or heteroaromatic group having 1 to 10 carbons; Y is nitrogen, oxygen, or sulfur; R^2 is independently a hydrocarbyl group having 1 to 9 carbons; each Z is nitrogen, oxygen, or sulfur; and R^3 is a hydrocarbyl group having 1 to 6 carbons with one or more nitrogen, oxygen, or sulfur functionalization, wherein p is 1 to 3, n is 1 to 20, and m is 1 to 3.

9. The method of claim 8, wherein the lubricant additive is present in about 0.1 to about 50.0 wt. % based on total weight of the lubricating oil composition.

10. The method of claim 8, wherein R¹ is a polyalkyl group.
11. The method of claim 8, wherein R¹ is a polyisobutenyl group.
12. The method of claim 8, further comprising a succinimide dispersant.
13. The method of claim 8, wherein the lubricating the engine improves deposit control or oxidation resistance in the engine.
14. The method of claim 8, wherein the lubricant additive has the following generalized structure:

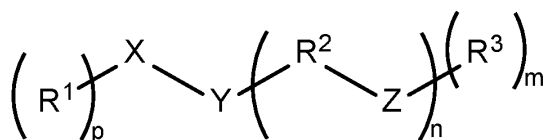


wherein each R¹ is independently a hydrocarbyl group having 10 to 400 carbons; Y is nitrogen, oxygen, or sulfur; each R² is independently a hydrocarbyl group having 1 to 9 carbons; each Z is nitrogen, oxygen, or sulfur; and each R³ is independently a hydrogen or hydrocarbyl group having 1 to 6 carbons with one or more nitrogen, oxygen, or sulfur functionalization, wherein p is 1 to 3, n is 1 to 20, and m is 1 to 3.

15. A method for improving piston cleanliness or oxidation inhibition in an engine, the method comprising lubricating the engine with a lubricating oil composition comprising:

a major amount of base oil; and

a lubricant additive having the following structure:



wherein each R^1 is independently a hydrocarbyl group having 10 to 400 carbons; X is an alkyl, aryl, or heteroaromatic group having 1 to 10 carbons; Y is nitrogen, oxygen, or sulfur; R^2 is independently a hydrocarbyl group having 1 to 9 carbons; each Z is nitrogen, oxygen, or sulfur; and R^3 is a hydrocarbyl group having 1 to 9 carbons with one or more nitrogen, oxygen, or sulfur functionalization, wherein p is 1 to 3, n is 1 to 20, and m is 1 to 3.

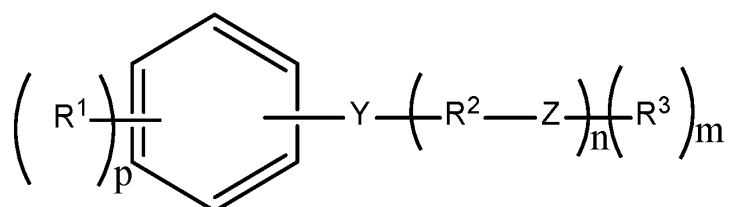
16. The method of claim 15, wherein the lubricant additive is present in about 0.1 to about 5 wt. % based on total weight of the lubricating oil composition.

17. The method of claim 15, wherein R^1 is a polyalkyl group.

18. The method of claim 15, wherein R^1 is a polyisobutenyl group.

19. The method of claim 15, further comprising a succinimide dispersant.

20. The method of claim 15, wherein the lubricant additive has the following generalized structure:



wherein each R^1 is independently a hydrocarbyl group having 10 to 400 carbons; Y is nitrogen, oxygen, or sulfur; each R^2 is independently a hydrocarbyl group having 1 to 9 carbons; each Z is nitrogen, oxygen, or sulfur; and each R^3 is independently a hydrogen or hydrocarbyl group having 1 to 6 carbons with one or more nitrogen, oxygen, or sulfur functionalization, wherein p is 1 to 3, n is 1 to 20, and m is 1 to 3.