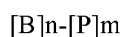


Claims

1. A lubricating oil composition comprising a biobased base oil, wherein the biobased base oil has the molecular structure:



wherein,

[B] is a biobased hydrocarbon repeating unit;

[P] is a non-biobased hydrocarbon repeating unit;

n is greater than 1, and m is less than 4; the stereoscopic arrangement of [B] and [P] is linear, branched or cyclic; the sequential arrangement of [B] and [P] is block, alternating or random; the molecular weight of the biobased base oil is in range of 300 g/mol to 1500 g/mol.

2. The lubricating oil composition of claim 1, wherein the composition further comprises a wear inhibitor, detergent, dispersant, friction modifier, viscosity index improver, pour point depressant, thickener, or antioxidant.
3. The lubricating oil composition of any preceding claim, wherein the composition further comprises a calcium detergent.
4. The lubricating oil composition of claim 3, wherein the calcium detergent is a calcium sulfonate, calcium salicylate, calcium carboxylate, or calcium phenate detergent.
5. The lubricating oil composition of claim 3, wherein the calcium detergent is one or more of a neutral, low overbased, medium overbased, high overbased or high high overbased calcium sulfonate, calcium salicylate, calcium carboxylate or calcium phenate detergent.
6. The lubricating oil composition of any preceding claim, wherein the composition further comprises a magnesium detergent.
7. The lubricating oil composition of claim 6, wherein the magnesium detergent is a magnesium sulfonate or magnesium salicylate detergent.
8. The lubricating oil composition of any preceding claim, wherein the composition further comprises a detergent derived from an isomerized normal alpha olefin.
9. The lubricating oil composition of claim 8, wherein the alkyl substituent of the calcium detergent is derived from an alpha olefin having from 12 to 40 carbon atoms per molecule.

10. The lubricating oil composition of claim 8, wherein the alkyl substituent of the calcium detergent is a residue derived from an isomerized normal alpha-olefin having from 14 to 28 carbon atoms per molecule.
11. The lubricating oil composition of claim 8, wherein the isomerized normal alpha olefin has an isomerization level (I) of the normal alpha olefin of from about 0.1 to about 0.4, where the isomerization level (I) of the olefin is determined by hydrogen-1 (1H) NMR obtained on a Bruker Ultrashield Plus 400 in chloroform-d1 at 400 MHz using TopSpin 3.2 spectral processing software, and the isomerization level (I) is:

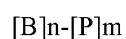
$$I = m/(m+n),$$

where m is NMR integral for methyl groups with chemical shifts between 0.3 ± 0.03 to 1.01 ± 0.03 ppm, and n is NMR integral for methylene groups with chemical shifts between 1.01 ± 0.03 to 1.38 ± 0.10 ppm.

12. The lubricating oil composition of any preceding claim, wherein the composition further comprises an ashless detergent.
13. The lubricating oil composition of any preceding claim, wherein the lubricating oil composition further comprises both a magnesium sulfonate detergent and a calcium salicylate detergent.
14. The lubricating oil composition of any preceding claim, wherein the lubricating oil composition further comprises a magnesium sulfonate detergent and a calcium detergent selected from calcium phenate and calcium sulfonate.
15. The lubricating oil composition of any preceding claim, wherein the lubricating oil composition further comprises from about 200 to about 3000 ppm of calcium, based on the weight of the lubricating oil composition.
16. The lubricating oil composition of any preceding claim, wherein the lubricating oil composition further comprises from about 100 to about 2000 ppm of magnesium, based on the weight of the lubricating oil composition.
17. The lubricating oil composition of any preceding claim, wherein the lubricating oil composition further comprises an organic friction modifier derived from a fatty acid source.
18. The lubricating oil composition of any preceding claim, wherein the lubricating oil composition further comprises an antioxidant in greater than 1.0 wt.% based on the total weight of the lubricating oil composition.

19. The lubricating oil composition of any preceding claim, wherein the lubricating oil composition further comprises an antioxidant in greater than 2.0 wt.% based on the total weight of the lubricating oil composition.
20. The lubricating oil composition of any preceding claim wherein the lubricating oil composition further comprises an antioxidant in greater than 3.0 wt.% based on the total weight of the lubricating oil composition.
21. The lubricating oil composition of any preceding claim, wherein the lubricating oil composition further comprises an antiwear additive selected from a C₄/C₆ secondary ZnDTP, C₃/C₆ primary, C₁₂ aryl, C₄/C₈ primary, C₃/C₆ secondary, C₃/C₈ secondary, and C₈ primary ZnDTP.
22. The lubricating oil composition of any preceding claim, wherein the lubricating oil composition further comprises a molybdenum compound in an amount from 50 to 2000 ppm of molybdenum based on the total weight of the lubricating oil composition and wherein the organomolybdenum compound is a sulfur-containing organomolybdenum compound or a non-sulfur-containing organomolybdenum compound.
23. The lubricating oil composition of any preceding claim, wherein the lubricating oil composition further comprises a molybdenum compound in an amount from 50 to 2000 ppm of molybdenum based on the total weight of the lubricating oil composition and wherein the molybdenum compound is a molybdenum-succinimide complex.
24. The lubricating oil composition of claim 23, wherein the molybdenum succinimide complex is derived from a C₂₄ to C₃₅₀ alkyl or alkenyl succinimide.
25. The lubricating oil composition of claim 23 or 24, wherein the succinimide is a polyisobutenyl succinimide derived from the reaction of a C₇₀ to C₁₂₈ polyisobutenyl succinic anhydride and a polyalkylene polyamine selected from triethylenetetramine, tetraethylenepentamine, and combinations thereof.
26. The lubricating oil composition of any of claims 1-22, wherein the lubricating oil composition further comprises a molybdenum compound in an amount from 50 to 2000 ppm of molybdenum based on the total weight of the lubricating oil composition and wherein the molybdenum compound is selected from the group consisting of molybdenum dithiocarbamates, molybdenum dithiophosphates, molybdenum carboxylates, molybdenum esters, molybdenum amines, molybdenum amides, and combinations thereof.

27. The lubricating oil composition of any preceding claim, wherein the lubricating oil composition has a viscosity index of greater than 200 and a NOACK volatility of less than 15%.
28. The lubricating oil composition of any preceding claim, wherein the lubricating oil composition has a viscosity index of greater than 250 and a NOACK volatility of less than 15%.
29. The lubricating oil composition of any preceding claim, wherein the lubricating oil is an automotive engine oil (spark or compression ignition, direct or port injected), hybrid engine oil, engine coupled to an electric motor/battery system in a hybrid vehicle oil, marine oil, gear oil, agricultural machinery oil, continuously variable transmission oil, manual transmission oil, automatic transmission oil, electric vehicle transmission oil, mobile natural gas oil, stationary natural gas oil, power railroad engine oil, power generation oil, hydraulic oil, dual fuel oil, tractor hydraulic fluid oil, anti-wear hydraulic fluid oil, hybrid driveline oil, motorcycle oil, grease, grease used under reduced pressure or high vacuum, reduction gears, hydraulic equipment, bearings used in aircraft, rockets, space engineering machinery, robot joints, or vacuum pump lubricating oil composition.
30. The lubricating oil composition of claim 29, wherein the lubricating oil composition is for an engine that is fueled in part or wholly fueled by a bio-derived fuel, ethanol, or methanol.
31. A 0W-4, 0W-8, 0W-12, 0W-16, 0W-20, 0W-30, 0W-40, 5W-20, or 5W-30 heavy duty or passenger car lubricating oil composition comprising: (a) from 1 to 99% by wt. of biobased base oil, wherein the biobased base oil has the molecular structure:



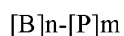
wherein,

[B] is a biobased hydrocarbon repeating unit;

[P] is a non-biobased hydrocarbon repeating unit;

n is greater than 1, and m is less than 4; the stereoscopic arrangement of [B] and [P] is linear, branched or cyclic; the sequential arrangement of [B] and [P] is block, alternating or random; the molecular weight of the biobased base oil is in range of 300 g/mol to 1500 g/mol; (b) from 1 to 99 wt.% of a secondary base oil, and (c) a minor amount of a dispersant inhibitor additive package.

32. The lubricating oil composition of claim 31, wherein the secondary base oil is a poly-alpha-olefin (PAO), aromatic, group I, group II, group III, ester base oil, or mixtures thereof having a KV 100 from about 2 cSt to about 30 cSt.
33. The lubricating oil composition of claim 31, wherein the secondary base oil is a poly-alpha-olefin (PAO), aromatic, group I, group II, group III, ester base oil, or mixtures thereof having a KV 100 from about 2 cSt to about 10 cSt.
34. The lubricating oil composition of claim 31, wherein the secondary base oil is a poly-alpha-olefin (PAO), aromatic, group I, group II, group III, ester base oil, or mixtures thereof having a KV 100 from about 2 cSt to about 6 cSt.
35. The lubricating oil composition of claim 31, wherein the secondary base oil is a poly-alpha-olefin (PAO), aromatic, group I, group II, group III, ester base oil or mixtures thereof having a KV 100 from about 2 cSt to about 4 cSt.
36. The lubricating oil composition of claim 31, wherein the secondary base oil is a poly-alpha-olefin (PAO), aromatic, group I, group II, group III, ester base oil, or mixtures thereof having a KV 100 from about 2 cSt to about 3 cSt.
37. The lubricating oil composition according to any preceding claim, wherein the lubricating oil is an automotive lubricant where the sulfated ash is less than 0.8, less than 0.7, less than 0.6, less than 0.5, less than 0.4, less than 0.3, less than 0.2 wt.% based on the lubricating oil composition.
38. The lubricating oil composition according to any preceding claim, wherein the lubricating oil is an automotive lubricant where the phosphorus content is less than 0.08, less than 0.07, less than 0.06, less than 0.05, less than 0.04, less than 0.03, less than 0.02 wt.% based on the lubricating oil composition.
39. The lubricating oil composition of claim 29, wherein the vacuum pump oil is ISO VG 32, 46, or 68.
40. A process oil comprising a biobased base oil, wherein the biobased base oil has the molecular structure:



wherein,

[B] is a biobased hydrocarbon repeating unit;

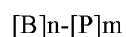
[P] is a non-biobased hydrocarbon repeating unit;

n is greater than 1, and m is less than 4; the stereoscopic arrangement of [B] and [P] is linear, branched or cyclic; the sequential arrangement of [B] and [P] is block,

:

alternating or random; the molecular weight of the biobased base oil is in range of 300 g/mol to 1500 g/mol.

41. Use of the process oil of claim 40 in the manufacture of a detergent.
42. A diluent oil comprising a biobased base oil, wherein the biobased base oil has the molecular structure:



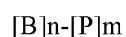
wherein,

[B] is a biobased hydrocarbon repeating unit;

[P] is a non-biobased hydrocarbon repeating unit;

n is greater than 1, and m is less than 4; the stereoscopic arrangement of [B] and [P] is linear, branched or cyclic; the sequential arrangement of [B] and [P] is block, alternating or random; the molecular weight of the biobased base oil is in range of 300 g/mol to 1500 g/mol.

43. Use of the diluent oil of claim 42 in the manufacture of a detergent.
44. An additive concentrate comprising (a) a biobased base oil, wherein the biobased base oil has the molecular structure:



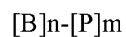
wherein,

[B] is a biobased hydrocarbon repeating unit;

[P] is a non-biobased hydrocarbon repeating unit;

n is greater than 1, and m is less than 4; the stereoscopic arrangement of [B] and [P] is linear, branched or cyclic; the sequential arrangement of [B] and [P] is block, alternating or random; the molecular weight of the biobased base oil is in range of 300 g/mol to 1500 g/mol and (b) a minor amount of a lubricant additive.

45. A viscosity index improver concentrate comprising (a) a biobased base oil, wherein the biobased base oil has the molecular structure:



wherein,

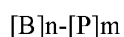
[B] is a biobased hydrocarbon repeating unit;

[P] is a non-biobased hydrocarbon repeating unit;

n is greater than 1, and m is less than 4; the stereoscopic arrangement of [B] and [P] is linear, branched or cyclic; the sequential arrangement of [B] and [P] is block, alternating or random; the molecular weight of the biobased base oil is in range of 300

g/mol to 1500 g/mol and (b) a minor amount of a viscosity index improver selected from olefin copolymer, diene-based copolymers, poly(meth)acrylate copolymers all of which can be a star, comb, or linear, and block, di-block or tri-block copolymers.

46. The viscosity index improver concentrate of claim 45, wherein the viscosity index improver is a dispersant viscosity index improver.
47. A solvent comprising a biobased base oil, wherein the biobased base oil has the molecular structure:



wherein,

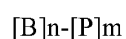
[B] is a biobased hydrocarbon repeating unit;

[P] is a non-biobased hydrocarbon repeating unit;

n is greater than 1, and m is less than 4; the stereoscopic arrangement of [B] and [P] is linear, branched or cyclic; the sequential arrangement of [B] and [P] is block, alternating or random; the molecular weight of the biobased base oil is in range of 300 g/mol to 1500 g/mol.

48. A method for reducing timing chain stretch in an engine comprising a step of lubricating said timing chain with a lubricating oil composition of any of claims 1 to 38.
49. A method for improving used oil low speed pre-ignition (LSPI) in an internal combustion engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 1 to 38, and (b) operating said engine for a period of time.
50. A method for reducing and/or inhibiting oxidation in the presence of biodiesel in an internal combustion engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 1 to 38, and (b) operating said engine for a period of time.
51. A method for suppressing or reducing NOACK volatility of a lubricating oil composition comprising formulating a lubricating oil composition of any of claims 1 to 38.
52. A method for improving piston cleanliness in an internal combustion engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 1 to 38, and (b) operating said engine for a period of time.

53. A method for reducing piston deposits in an internal combustion engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 1 to 38, and (b) operating said engine for a period of time.
54. A method for reducing turbocharger deposits in an internal combustion engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 1 to 38, and (b) operating said engine for a period of time.
55. A method for reducing deposits in an internal combustion engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 1 to 38, and (b) operating said engine for a period of time.
56. A method for improving oil mist separator cleanliness (OMS) in an internal combustion engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 1 to 38, and (b) operating said engine for a period of time.
57. A method for improving fresh oil heavy duty (HD) or passenger car (PC) fuel economy in an internal combustion engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 1 to 38, and (b) operating said engine for a period of time.
58. The method of any of claims 53 to 57 wherein deposits are reduced in intercooler systems and their tubing.
59. A method for improving fuel economy retention in a heavy duty (HD) or passenger car (PC) engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 1 to 38, and (b) operating said engine for a period of time.
60. A method for improving seal elastomer compatibility in an internal combustion engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 1 to 38, and (b) operating said engine for a period of time.
61. A method for improving oxidative stability in an internal combustion engine comprising the steps of lubricating the engine with a lubricating oil composition of any of claims 1 to 38, and (b) operating said engine for a period of time.
62. A method for improving additive package stability comprising adding to said package a biobased base oil having the molecular structure:



wherein,

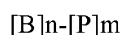
[B] is a biobased hydrocarbon repeating unit;

[P] is a non-biobased hydrocarbon repeating unit;

:

n is greater than 1, and m is less than 4; the stereoscopic arrangement of [B] and [P] is linear, branched or cyclic; the sequential arrangement of [B] and [P] is block, alternating or random; the molecular weight of the biobased base oil is in range of 300 g/mol to 1500 g/mol.

63. A method for improving additive package solubility comprising adding to said package a biobased base oil having the molecular structure:



wherein,

[B] is a biobased hydrocarbon repeating unit;

[P] is a non-biobased hydrocarbon repeating unit;

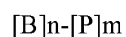
n is greater than 1, and m is less than 4; the stereoscopic arrangement of [B] and [P] is linear, branched or cyclic; the sequential arrangement of [B] and [P] is block, alternating or random; the molecular weight of the biobased base oil is in range of 300 g/mol to 1500 g/mol.

64. A method for improving low temperature properties of a lubricating oil composition in an internal combustion engine comprising the steps of lubricating the engine with a lubricating oil composition of any of claims 1 to 38 and operating said engine, wherein the properties of both fresh and used oils are determined by Pour Point, CCS, MRV, Gelation Index, ROBO, Mack T10A/T11A/T12A tests.
65. A method for inhibiting corrosion in an internal combustion engine comprising the steps of lubricating the engine with a lubricating oil composition of any of claims 1 to 38 and operating said engine.
66. A method for inhibiting foam formation in an internal combustion engine comprising the steps of lubricating the engine with a lubricating oil composition of any of claims 1 to 38 and operating said engine.
67. A method for improving aeration control in an internal combustion engine comprising the steps of lubricating the engine with a lubricating oil composition of any of claims 1 to 38 and operating said engine.
68. A method for stabilizing an emulsion in an internal combustion engine that becomes contaminated with fuel and/or water comprising the steps of lubricating the engine with a lubricating oil composition of any of claims 1 to 38 and operating said engine.

69. A method for reducing friction in an internal combustion engine comprising the steps of lubricating an engine with a lubricating oil composition of any of claims 1 to 38 and operating said engine.
70. A method for reducing sludge formation in an internal combustion engine comprising the steps of lubricating an engine with a lubricating oil composition of any of claims 1 to 38 and operating said engine.
71. A method improving fresh oil wear performance in an internal combustion engine comprising the steps of lubricating an engine with a lubricating oil composition of any of claims 1 to 38 and operating said engine for a period of time.
72. A method improving used oil wear performance in an internal combustion engine comprising the steps of lubricating an engine with a lubricating oil composition of any of claims 1 to 38 and operating said engine for a period of time.
73. A method reducing oil consumption in an internal combustion engine comprising the steps of lubricating an engine with a lubricating oil composition of any of claims 1 to 38 and operating said engine for a period of time.
74. A method for extending oil drain intervals comprising the steps of lubricating an internal combustion engine with a lubricating oil composition of any of claims 1 to 38 and operating said engine for a period of time.
75. A method for improving compatibility with after treatment devices selected from a gasoline particulate filter (GPF), diesel particulate filter (DPF), EGR system, diesel oxidation catalyst (DOC), lean NOx trap (LNT), or selective catalytic reduction (SCR) comprising the steps of lubricating an internal combustion engine with a lubricating oil composition of any of claims 1 to 38 and operating said engine for a period of time.
76. A method for improving BioDiesel compatibility, as measured measured in CEC L-109-16 and or L105-12 tests, comprising the steps of lubricating an internal combustion engine with a lubricating oil composition of any of claims 1 to 38 and operating said engine for a period of time.
77. A method for preventing or inhibiting deposit formation in a natural gas engine containing one or more steel pistons comprising the step of operating the natural gas engine with a natural gas engine lubricating oil composition of any of claims 1 to 29.
78. A method of improving brake and clutch capacity while maintaining low torque variation at low speed of a tractor hydraulic system, the method comprising lubricating said hydraulic system with a lubricating oil composition of any of claims 1 to 29.

79. The lubricating oil composition of any of claims 1 to 28, wherein the lubricating oil composition is a marine lubricating oil composition wherein the marine lubricating oil composition is a system oil, a marine cylinder lubricating oil (MCL), or a trunk piston oil (TPEO) composition.
80. The lubricating oil composition of claim 79, wherein the lubricating oil composition is a monograde lubricant meeting specifications for SAE J300 revised January 2015 requirements for a SAE 20, 30, 40, 50, or 60 monograde engine oil, and has a TBN of 5 to 200 mg KOH/g, as determined by ASTM D2896.
81. The lubricating oil composition of claim 79 or 80, wherein the lubricating oil composition has a TBN in one of the following ranges: 5 to 200 mg KOH/g, 5 to 150 mg KOH/g, 5 to 100 mg KOH/g, 15 to 150 mg KOH/g, 20 to 80 mg KOH/g, 30 to 100 mg KOH/g, 30 to 80 mg KOH/g, 60 to 100 mg KOH/g, 60 to 150 mg KOH/g, 20 to 70 mg KOH/g, 15 to 55 mg KOH/g, and 5 to 15 mg KOH/g.
82. The lubricating oil composition of any of claims 79 to 81, wherein the composition is for an engine that is fueled in part or wholly fueled by a bio-derived fuel, ethanol, or methanol, ammonia, a gaseous fuel, a residual fuel, a marine residual fuel, a low sulfur marine residual fuel, a marine distillate fuel, a low sulfur marine distillate fuel, or a high sulfur fuel.
83. The lubricating oil composition of any of claims 79 to 82, wherein the composition is for a compression-ignited 4-stroke internal combustion engine operated at 250 to 1100 rpm.
84. The lubricating oil composition of any of claims 79 to 82, wherein the lubricant is for a compression-ignited 2-stroke internal combustion engine operated at 200 rpm or less.
85. A method for improving the fuel economy of a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 79 to 84 and operating said engine.
86. A method for improving the oil consumption of a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 79 to 84 and operating said engine.
87. A method for improving low temperature properties of a lubricating oil composition in a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 79 to 84 and operating said engine.

88. A method for improving the neutralization capability of a lubricating oil composition in a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 79 to 84 and operating said engine.
89. A method for improving the wear performance of a lubricating oil composition in a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 79 to 84 and operating said engine.
90. A method for improving the oxidative stability of a lubricating oil composition in a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 79 to 84 and operating said engine.
91. A method for reducing sludge formation in a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 79 to 84 and operating said engine.
92. A method for improving viscosity increase control in a diesel internal combustion engine, comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 79 to 84 and operating said engine.
93. A method for reducing scuffing in a diesel internal combustion engine, comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 79 to 84 and operating said engine.
94. A method for reducing deposits in a diesel internal combustion engine, comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 79 to 84 and operating said engine.
95. A method for reducing the rate of depletion of basicity of a lubricating oil composition in a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 79 to 84 and operating said engine.
96. A method for inhibiting foam formation of a lubricating oil composition in a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 79 to 84 and operating said engine.
97. A method for improving asphaltene dispersancy of a lubricating oil composition in a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 79 to 84 and operating said engine.
98. A method for thickening a lubricating oil composition comprising adding to said lubricating oil composition a biobased base oil having the molecular structure:



:

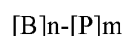
wherein,

[B] is a biobased hydrocarbon repeating unit;

[P] is a non-biobased hydrocarbon repeating unit;

n is greater than 1, and m is less than 4; the stereoscopic arrangement of [B] and [P] is linear, branched or cyclic; the sequential arrangement of [B] and [P] is block, alternating or random; the molecular weight of the biobased base oil is in range of 300 g/mol to 1500 g/mol.

99. A method for improving storage stability of a lubricating oil composition comprising adding to said lubricating oil composition a biobased base oil having the molecular structure:



wherein,

[B] is a biobased hydrocarbon repeating unit;

[P] is a non-biobased hydrocarbon repeating unit;

n is greater than 1, and m is less than 4; the stereoscopic arrangement of [B] and [P] is linear, branched or cyclic; the sequential arrangement of [B] and [P] is block, alternating or random; the molecular weight of the biobased base oil is in range of 300 g/mol to 1500 g/mol.

100. A lubricating oil composition comprising a biobased base oil, wherein the biobased base oil is described by a hydrocarbon mixture in which:
- the percentage of molecules with even carbon number is $\geq 80\%$ according to FIMS;
 - the $BP/BI \geq -0.6037$ (Internal alkyl branching per molecule)+2.0;
 - on average there are 0.3 to 1.5 5+ methyl per molecule.
101. The lubricating oil composition of claim 100, wherein the composition further comprises a wear inhibitor, detergent, dispersant, friction modifier, viscosity index improver, pour point depressant, thickener, or antioxidant.
102. The lubricating oil composition of claim 100 or 101, wherein the composition further comprises a calcium detergent.
103. The lubricating oil composition of claim 102, wherein the calcium detergent is a calcium sulfonate, calcium salicylate, calcium carboxylate, or calcium phenate detergent.

104. The lubricating oil composition of claim 102, wherein the calcium detergent is one or more of a neutral, low overbased, medium overbased, high overbased or high high overbased calcium sulfonate, calcium salicylate, calcium carboxylate or calcium phenate detergent.
105. The lubricating oil composition of any of claims 100 to 104, wherein the composition further comprises a magnesium detergent.
106. The lubricating oil composition of claim 105, wherein the magnesium detergent is a magnesium sulfonate or magnesium salicylate detergent.
107. The lubricating oil composition of any of claims 100 to 106, wherein the composition further comprises a detergent derived from an isomerized normal alpha olefin.
108. The lubricating oil composition of claim 107, wherein the alkyl substituent of the calcium detergent is derived from an alpha olefin having from 12 to 40 carbon atoms per molecule.
109. The lubricating oil composition of claim 107, wherein the alkyl substituent of the calcium detergent is a residue derived from an isomerized normal alpha-olefin having from 14 to 28 carbon atoms per molecule.
110. The lubricating oil composition of claim 107, wherein the isomerized normal alpha olefin has an isomerization level (I) of the normal alpha olefin of from about 0.1 to about 0.4, where the isomerization level (I) of the olefin is determined by hydrogen-1 (1H) NMR obtained on a Bruker Ultrashield Plus 400 in chloroform-d1 at 400 MHz using TopSpin 3.2 spectral processing software, and the isomerization level (I) is:
- $$I = m/(m+n),$$
- where m is NMR integral for methyl groups with chemical shifts between 0.3 ± 0.03 to 1.01 ± 0.03 ppm, and n is NMR integral for methylene groups with chemical shifts between 1.01 ± 0.03 to 1.38 ± 0.10 ppm.
111. The lubricating oil composition of any of claims 100 to 110, wherein the composition further comprises an ashless detergent.
112. The lubricating oil composition of any of claims 100 to 111, wherein the lubricating oil composition further comprises both a magnesium sulfonate detergent and a calcium salicylate detergent.

113. The lubricating oil composition of any of claims 100 to 112, wherein the lubricating oil composition further comprises a magnesium sulfonate detergent and a calcium detergent selected from calcium phenate and calcium sulfonate.
114. The lubricating oil composition of any of claims 100 to 113, wherein the lubricating oil composition further comprises from about 200 to about 3000 ppm of calcium, based on the weight of the lubricating oil composition.
115. The lubricating oil composition of any of claims 100 to 114, wherein the lubricating oil composition further comprises from about 100 to about 2000 ppm of magnesium, based on the weight of the lubricating oil composition.
116. The lubricating oil composition of any of claims 100 to 115, wherein the lubricating oil composition further comprises an organic friction modifier derived from a fatty acid source.
117. The lubricating oil composition of any of claims 100 to 116, wherein the lubricating oil composition further comprises an antioxidant in greater than 1.0 wt.% based on the total weight of the lubricating oil composition.
118. The lubricating oil composition of any of claims 100 to 117, wherein the lubricating oil composition further comprises an antioxidant in greater than 2.0 wt.% based on the total weight of the lubricating oil composition.
119. The lubricating oil composition of any of claims 100 to 118 wherein the lubricating oil composition further comprises an antioxidant in greater than 3.0 wt.% based on the total weight of the lubricating oil composition.
120. The lubricating oil composition of any of claims 100 to 119, wherein the lubricating oil composition further comprises an antiwear additive selected from a C₄/C₆ secondary ZnDTP, C₃/C₆ primary, C₁₂ aryl, C₄/C₈ primary, C₃/C₆ secondary, C₃/C₈ secondary, and C₈ primary ZnDTP.
121. The lubricating oil composition of any of claims 100 to 120, wherein the lubricating oil composition further comprises a molybdenum compound in an amount from 50 to 2000 ppm of molybdenum based on the total weight of the lubricating oil composition and wherein the organomolybdenum compound is a sulfur-containing organomolybdenum compound or a non-sulfur-containing organomolybdenum compound.
122. The lubricating oil composition of any of claims 100 to 121, wherein the lubricating oil composition further comprises a molybdenum compound in an amount

from 50 to 2000 ppm of molybdenum based on the total weight of the lubricating oil composition and wherein the molybdenum compound is a molybdenum-succinimide complex.

123. The lubricating oil composition of claim 122, wherein the molybdenum succinimide complex is derived from a C₂₄ to C₃₅₀ alkyl or alkenyl succinimide.
124. The lubricating oil composition of claim 122, wherein the succinimide is a polyisobutenyl succinimide derived from the reaction of a C₇₀ to C₁₂₈ polyisobutenyl succinic anhydride and a polyalkylene polyamine selected from triethylenetetramine, tetraethylenepentamine, and combinations thereof.
125. The lubricating oil composition of any of claims 100-121, wherein the lubricating oil composition further comprises a molybdenum compound in an amount from 50 to 2000 ppm of molybdenum based on the total weight of the lubricating oil composition and wherein the molybdenum compound is selected from the group consisting of molybdenum dithiocarbamates, molybdenum dithiophosphates, molybdenum carboxylates, molybdenum esters, molybdenum amines, molybdenum amides, and combinations thereof.
126. The lubricating oil composition of any of claims 100 to 125, wherein the lubricating oil composition has a viscosity index of greater than 200 and a NOACK volatility of less than 15%.
127. The lubricating oil composition of any of claims 100 to 126, wherein the lubricating oil composition has a viscosity index of greater than 250 and a NOACK volatility of less than 15%.
128. The lubricating oil composition of any of claims 100 to 127, wherein the lubricating oil is an automotive engine oil (spark or compression ignition, direct or port injected), hybrid engine oil, engine coupled to an electric motor/battery system in a hybrid vehicle oil, marine oil, gear oil, agricultural machinery oil, continuously variable transmission oil, manual transmission oil, automatic transmission oil, electric vehicle transmission oil, mobile natural gas oil, stationary natural gas oil, power railroad engine oil, power generation oil, hydraulic oil, dual fuel oil, tractor hydraulic fluid oil, anti-wear hydraulic fluid oil, hybrid driveline oil, motorcycle oil, grease, grease used under reduced pressure or high vacuum, reduction gears, hydraulic equipment, bearings used in aircraft, rockets, space engineering machinery, robot joints, or vacuum pump lubricating oil composition.

129. The lubricating oil composition of claim 128, wherein the lubricating oil composition is for an engine that is fueled in part or wholly fueled by a bio-derived fuel, ethanol, or methanol.
130. A 0W-4, 0W-8, 0W-12, 0W-16, 0W-20, 0W-30, 0W-40, 5W-20, or 5W-30 heavy duty or passenger car lubricating oil composition comprising (a) from 1 to 99% by wt. of biobased base oil, wherein the biobased base oil is described by a hydrocarbon mixture in which:
- i. the percentage of molecules with even carbon number is $\geq 80\%$ according to FIMS;
 - ii. the $BP/BI \geq -0.6037$ (Internal alkyl branching per molecule)+2.0;
 - iii. on average there are 0.3 to 1.5 5+ methyl per molecule;
- (b) from 1 to 99 wt.% of a secondary base oil, and (c) a minor amount of a dispersant inhibitor additive package.
131. The lubricating oil composition of claim 130, wherein the secondary base oil is a poly-alpha-olefin (PAO), aromatic, group I, group II, group III, ester base oil or mixtures thereof having a KV 100 from about 2 cSt to about 30 cSt.
132. The lubricating oil composition of claim 130, wherein the secondary base oil is a poly-alpha-olefin (PAO), aromatic, group I, group II, group III, ester base oil, or mixtures thereof having a KV 100 from about 2 cSt to about 10 cSt.
133. The lubricating oil composition of claim 130, wherein the secondary base oil is a poly-alpha-olefin (PAO), aromatic, group I, group II, group III, ester base oil, or mixtures thereof having a KV 100 from about 2 cSt to about 6 cSt.
134. The lubricating oil composition of claim 130, wherein the secondary base oil is a poly-alpha-olefin (PAO), aromatic, group I, group II, group III, ester base oil, or mixtures thereof having a KV 100 from about 2 cSt to about 4 cSt.
135. The lubricating oil composition of claim 130, wherein the secondary base oil is a poly-alpha-olefin (PAO), aromatic, group I, group II, group III, ester base oil, or mixtures thereof having a KV 100 from about 2 cSt to about 3 cSt.
136. The lubricating oil composition of any of claims 100 to 135, wherein the lubricating oil is an automotive lubricant where the sulfated ash is less than 0.8, less than 0.7, less than 0.6, less than 0.5, less than 0.4, less than 0.3, less than 0.2 wt.% based on the lubricating oil composition.

137. The lubricating oil composition of any of claims 100-136, wherein the lubricating oil is an automotive lubricant where the phosphorus content is less than 0.08, less than 0.07, less than 0.06, less than 0.05, less than 0.04, less than 0.03, less than 0.02 wt.% based on the lubricating oil composition.
138. The lubricating oil composition of claim 128, wherein the vacuum pump oil is ISO VG 32, 46, or 68.
139. A process oil comprising a biobased base oil, wherein the biobased base oil is described by a hydrocarbon mixture in which:
- the percentage of molecules with even carbon number is $\geq 80\%$ according to FIMS;
 - the $BP/BI \geq -0.6037$ (Internal alkyl branching per molecule)+2.0;
 - on average there are 0.3 to 1.5 5+ methyl per molecule.
140. Use of the process oil of claim 139 in the manufacture of a detergent.
141. A diluent oil comprising a biobased base oil, wherein the biobased base oil is described by a hydrocarbon mixture in which:
- the percentage of molecules with even carbon number is $\geq 80\%$ according to FIMS;
 - the $BP/BI \geq -0.6037$ (Internal alkyl branching per molecule)+2.0;
 - on average there are 0.3 to 1.5 5+ methyl per molecule.
142. Use of the diluent oil of claim 141 in the manufacture of a detergent.
143. An additive concentrate comprising (a) a biobased base oil, wherein the biobased base oil is described by a hydrocarbon mixture in which:
- the percentage of molecules with even carbon number is $\geq 80\%$ according to FIMS;
 - the $BP/BI \geq -0.6037$ (Internal alkyl branching per molecule)+2.0;
 - on average there are 0.3 to 1.5 5+ methyl per molecule; and
- (b) a minor amount of a lubricant additive.
144. A viscosity index improver concentrate comprising (a) a biobased base oil, wherein the biobased base oil is described by a hydrocarbon mixture in which:
- the percentage of molecules with even carbon number is $\geq 80\%$ according to FIMS;
 - the $BP/BI \geq -0.6037$ (Internal alkyl branching per molecule)+2.0;
 - on average there are 0.3 to 1.5 5+ methyl per molecule; and

- (b) a minor amount of a viscosity index improver selected from olefin copolymer, diene-based copolymers, poly(meth)acrylate copolymers all of which can be a star, comb, or linear, and block, di-block or tri-block copolymers.
145. The viscosity index improver concentrate of claim 144, wherein the viscosity index improver is a dispersant viscosity index improver.
146. A solvent comprising a biobased base oil, wherein the biobased base oil is described by a hydrocarbon mixture in which:
- the percentage of molecules with even carbon number is $\geq 80\%$ according to FIMS;
 - the $BP/BI \geq -0.6037$ (Internal alkyl branching per molecule)+2.0;
 - on average there are 0.3 to 1.5 5+ methyl per molecule.
147. A method for reducing timing chain stretch in an engine comprising a step of lubricating said timing chain with a lubricating oil composition of any of claims 100 to 137.
148. A method for improving used oil low speed pre-ignition (LSPI) in an internal combustion engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 100 to 137, and (b) operating said engine for a period of time.
149. A method for reducing and/or inhibiting oxidation in the presence of biodiesel in an internal combustion engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 100 to 137, and (b) operating said engine for a period of time.
150. A method for suppressing or reducing NOACK volatility of a lubricating oil composition comprising formulating a lubricating oil composition of any of claims 100 to 137.
151. A method for improving piston cleanliness in an internal combustion engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 100 to 137, and (b) operating said engine for a period of time.
152. A method for reducing piston deposits in an internal combustion engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 100 to 137, and (b) operating said engine for a period of time.

153. A method for reducing turbocharger deposits in an internal combustion engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 100 to 137, and (b) operating said engine for a period of time.
154. A method for reducing deposits in an internal combustion engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 100 to 137, and (b) operating said engine for a period of time.
155. A method for improving oil mist separator cleanliness (OMS) in an internal combustion engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 100 to 137, and (b) operating said engine for a period of time.
156. A method for improving fresh oil heavy duty (HD) or passenger car (PC) fuel economy in an internal combustion engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 100 to 137, and (b) operating said engine for a period of time.
157. The method of any of claims 152 to 156 wherein deposits are reduced in intercooler systems and their tubing.
158. A method for improving fuel economy retention in a heavy duty (HD) or passenger car (PC) engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 100 to 137, and (b) operating said engine for a period of time.
159. A method for improving seal elastomer compatibility in an internal combustion engine comprising the steps of (a) lubricating the engine with a lubricating oil composition of any of claims 100 to 137, and (b) operating said engine for a period of time.
160. A method for improving oxidative stability in an internal combustion engine comprising the steps of lubricating the engine with a lubricating oil composition of any of claims 100 to 137, and (b) operating said engine for a period of time.
161. A method for improving additive package stability comprising adding a biobased base oil which is described by a hydrocarbon mixture in which:
- the percentage of molecules with even carbon number is $\geq 80\%$ according to FIMS;
 - the $BP/BI \geq -0.6037$ (Internal alkyl branching per molecule)+2.0;
 - on average there are 0.3 to 1.5 5+ methyl per molecule.

162. A method for improving additive package solubility comprising adding a biobased base oil which is described by a hydrocarbon mixture in which:
- a. the percentage of molecules with even carbon number is $\geq 80\%$ according to FIMS;
 - b. the $BP/BI \geq -0.6037$ (Internal alkyl branching per molecule)+2.0;
 - c. on average there are 0.3 to 1.5 5+ methyl per molecule.
163. A method for improving low temperature properties of a lubricating oil composition in an internal combustion engine comprising the steps of lubricating the engine with a lubricating oil composition of any of claims 100 to 137 and operating said engine.
164. A method for inhibiting corrosion in an internal combustion engine comprising the steps of lubricating the engine with a lubricating oil composition of any of claims 100 to 137 and operating said engine.
165. A method for inhibiting foam formation in an internal combustion engine comprising the steps of lubricating the engine with a lubricating oil composition of any of claims 100 to 137 and operating said engine.
166. A method for improving aeration control in an internal combustion engine comprising the steps of lubricating the engine with a lubricating oil composition of any of claims 100 to 137 and operating said engine.
167. A method for stabilizing an emulsion in an internal combustion engine that becomes contaminated with fuel and/or water comprising the steps of lubricating the engine with a lubricating oil composition of any of claims 100 to 137 and operating said engine.
168. A method for reducing friction in an internal combustion engine comprising the steps of lubricating the engine with a lubricating oil composition of any of claims 100 to 137 and operating said engine.
169. A method for reducing sludge formation in an internal combustion engine comprising the steps of lubricating the engine with a lubricating oil composition of any of claims 100 to 137 and operating said engine.
170. A method improving fresh oil wear performance in an internal combustion engine comprising the steps of lubricating an engine with a lubricating oil composition of any of claims 100 to 137 and operating said engine for a period of time.

171. A method improving used oil wear performance in an engine comprising the steps of lubricating an internal combustion engine with a lubricating oil composition of any of claims 100 to 137 and operating said engine for a period of time.
172. A method improving oil consumption in an internal combustion engine comprising the steps of lubricating an engine with a lubricating oil composition of any of claims 100 to 137 and operating said engine for a period of time.
173. A method for extending oil drain intervals comprising the steps of lubricating an internal combustion engine with a lubricating oil composition of any of claims 100 to 137 and operating said engine for a period of time.
174. A method for improving compatibility with after treatment devices selected from a gasoline particulate filter (GPF), diesel particulate filter (DPF), EGR systems, diesel oxidation catalyst (DOC), lean NO_x trap (LNT), or selective catalytic reduction (SCR) comprising the steps of lubricating an engine with a lubricating oil composition of any of claims 100 to 137 and operating said engine for a period of time.
175. A method for improving BioDiesel compatibility, as measured in CEC L-109-16 and or L105-12 tests, comprising the steps of lubricating an internal combustion engine with a lubricating oil composition of any of claims 100 to 137 and operating said engine for a period of time.
176. A method for preventing or inhibiting deposit formation in a natural gas engine containing one or more steel pistons, or one or more aluminum pistons, comprising the step of operating the natural gas engine with a natural gas engine lubricating oil composition of any of claims 100 to 128.
177. A method of improving brake and clutch capacity while maintaining low torque variation at low speed of a tractor hydraulic system, the method comprising lubricating said hydraulic system with a lubricating oil composition of any of claims 100 to 128.
178. The lubricating oil composition of any of claims 100 to 127, wherein the lubricating oil composition is a marine lubricating oil composition wherein the marine lubricating oil composition is a system oil, a marine cylinder lubricating oil (MCL), or a trunk piston oil (TPEO) composition.
179. The lubricating oil composition of claim 178, wherein the lubricating oil composition is a monograde lubricant meeting specifications for SAE J300 revised January 2015 requirements for a SAE 20, 30, 40, 50, or 60 monograde engine oil, and has a TBN of 5 to 200 mg KOH/g, as determined by ASTM D2896.

180. The lubricating oil composition of claim 178 or 179, wherein the lubricating oil composition has a TBN in one of the following ranges: 5 to 200 mg KOH/g, 5 to 150 mg KOH/g, 5 to 100 mg KOH/g, 15 to 150 mg KOH/g, 20 to 80 mg KOH/g, 30 to 100 mg KOH/g, 30 to 80 mg KOH/g, 60 to 100 mg KOH/g, 60 to 150 mg KOH/g, 20 to 70 mg KOH/g, 15 to 55 mg KOH/g, and 5 to 15 mg KOH/g.
181. The lubricating oil composition of any of claims 178 to 180, wherein the composition is for an engine that is fueled in part or wholly fueled by a bio-derived fuel, ethanol, or methanol, ammonia, a gaseous fuel, a residual fuel, a marine residual fuel, a low sulfur marine residual fuel, a marine distillate fuel, a low sulfur marine distillate fuel, or a high sulfur fuel.
182. The lubricating oil composition of any of claims 178 to 181, wherein the composition is for a compression-ignited 4-stroke internal combustion engine operated at 250 to 1100 rpm.
183. The lubricating oil composition of any of claims 178-181, wherein the lubricant is for a compression-ignited 2-stroke internal combustion engine operated at 200 rpm or less.
184. A method for improving the fuel economy of a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 178 to 183 and operating said engine.
185. A method for improving the oil consumption of a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 178 to 183 and operating said engine.
186. A method for improving low temperature properties of a lubricating oil composition in a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 178 to 183 and operating said engine.
187. A method for improving the neutralization capability of a lubricating oil composition in a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 178 to 183 and operating said engine.
188. A method for improving the wear performance of a lubricating oil composition in a diesel internal combustion engine comprising the steps of lubricating said engine

with the lubricating oil composition of any of claims 178 to 183 and operating said engine.

189. A method for improving the oxidative stability of a lubricating oil composition in a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 178 to 183 and operating said engine.
190. A method for reducing sludge formation in a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 178 to 183 and operating said engine.
191. A method for improving viscosity increase control in a diesel internal combustion engine, comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 178 to 183 and operating said engine.
192. A method for reducing scuffing in a diesel internal combustion engine, comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 178 to 183 and operating said engine.
193. A method for reducing deposits in a diesel internal combustion engine, comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 178 to 183 and operating said engine.
194. A method for reducing the rate of depletion of basicity of a lubricating oil composition in a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 178 to 183 and operating said engine.
195. A method for inhibiting foam formation of a lubricating oil composition in a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 178 to 183 and operating said engine.
196. A method for improving asphaltene dispersancy of a lubricating oil composition in a diesel internal combustion engine comprising the steps of lubricating said engine with the lubricating oil composition of any of claims 178 to 183 and operating said engine.
197. A method for thickening a lubricating oil composition for a diesel internal combustion engine comprising adding to said lubricating oil composition a biobased base oil which is described by a hydrocarbon mixture in which:

- a. the percentage of molecules with even carbon number is $\geq 80\%$ according to FIMS;
 - b. the $BP/BI \geq -0.6037 (\text{Internal alkyl branching per molecule}) + 2.0$;
 - c. on average there are 0.3 to 1.5 5+ methyl per molecule.
198. A method for improving storage stability of a lubricating oil composition comprising adding a biobased base oil which is described by a hydrocarbon mixture in which:
- a. the percentage of molecules with even carbon number is $\geq 80\%$ according to FIMS;
 - b. the $BP/BI \geq -0.6037 (\text{Internal alkyl branching per molecule}) + 2.0$;
 - c. on average there are 0.3 to 1.5 5+ methyl per molecule.