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(54) **ENGINE OIL COMPOSITIONS AND
PREPARATION THEREOF**

(75) Inventors: **Peter Kleijwegt**, Heinenoord (NL);
Stephen J. Miller, San Francisco, CA
(US); **John M. Rosenbaum**, Richmond,
CA (US); **Nancy J. Bertrand**,
Lafayette, CA (US); **Matthew Ansari**,
San Ramon, CA (US); **Max I. Chang**,
Choa Chu Kang (SG)

Correspondence Address:
CHEVRON CORPORATION
P.O. BOX 6006
SAN RAMON, CA 94583-0806 (US)

(73) Assignee: **Chevron U.S.A. Inc.**

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(57) **ABSTRACT**

A multi-grade engine oil composition meeting required specifications of manufacturers is provided. In one embodiment, the engine oil composition contains a sufficient amount of a Pour Point Reducing Blend Component for the engine oil to have cold crank simulator viscosity at -20° C. of less than have a cold crank simulator viscosity at -20° C. of less than 9000 cP and a mini rotary viscometer (MRV) viscosity at -20° C. of less than 60,000 cP. The Pour Point Reducing Blend Component is selected from 1) an isomerized Fischer-Tropsch derived bottoms product; 2) a bottoms product prepared from an isomerized highly waxy mineral oil, or 3) an isomerized oil having a kinematic viscosity at 100° C. of at least about 8 mm²/s made from polyethylene plastic.

ENGINE OIL COMPOSITIONS AND PREPARATION THEREOF

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of U.S. patent application Ser. No. 11/159,282 filed Jun. 22, 2005. This application claims priority to and benefits under 35 USC 119 of Provisional Application U.S. Ser. No. 60/975,713 filed Sep. 27, 2007. This application claims priority to and benefits from all of the foregoing, the disclosures of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The invention relates generally to engine oil compositions, and more specifically to multi-grade engine oil compositions having a reduced level of viscosity modifiers.

BACKGROUND

[0003] Engine oil formulations have become increasingly complex with the stringent demands made by the developing automotive industry, e.g., lubricants which can be utilized over a wide range of operating conditions including temperature variations. At the same time, the formulated lubricants must also possess an ability to impart oxidative stability, detergency, dispersancy, wear inhibition and corrosion inhibition during its use as well as during storage. Furthermore, the automotive industry desires lubricants which will stay in their viscosity grades for a substantial length of time again under both use and storage conditions. By "multi-grade lubricants" is meant lubricants which meet a 0° F. viscosity specification and a 210° F. viscosity specification, according to SAE standard (Society of Automotive Engineer) SAE J300.

[0004] Engine oil compositions in the prior art typically employ a Group I, II, III, a synthetic PAO (for poly α -olefin) or mixtures thereof as a base oil stock. The groups are broad categories of base stocks developed by the American Petroleum Institute (API). Viscosity index improvers (or viscosity modifiers) are needed in engine oil compositions to meet standard viscosity requirements of multi-grade engine oils. Viscosity index improvers are expensive and may shear in service. Additionally, low content of viscosity index improvers is a key to meeting European engine deposit tests.

[0005] Recent reforming processes have formed a new class of oil, i.e., Fischer Tropsch base oil (FTBO), wherein the oil, fraction, or feed originates from or is produced at some stage by a Fischer-Tropsch process, as disclosed in a number of patent publications and applications, i.e., US 2006/0289337, US2006/0201851, US2006/006721, US2006/0016724, US2006/10076267, US2006/020185, US2006/013210, US2005/0241990, US2005/0077208, US2005/0139513, US2005/0139514, US2005/0133409, US2005/0133407, US2005/0261147, US2005/0261146, US2005/0261145, US2004/0159582, US7018525, US708317133, U.S. application Ser. No. 11/400,570, Ser. No. 11/535,165 and Ser. No. 11/6139,36, which are incorporated herein by reference. In these references, a Fischer Tropsch base oil is produced from a process in which the feed is a waxy feed recovered from a Fischer-Tropsch synthesis. In the process, the bottoms material collected from the hydroisomerized vacuum column comprises a

mixture of high boiling hydrocarbons, with an average molecular weight of about 600 to 1100 Daltons (g/mol) and has a generally high kinematic viscosity of about 8 mm²/s (cSt) to about 22 mm²/s at 100° C.

[0006] There is a need for improved engine oil compositions having reduced levels of viscosity modifiers particularly engine oil compositions employing alternative hydrocarbon sources such as Fischer Tropsch base oils. There is also a need for improved engine oil compositions meeting all the requirements of SAE J300 over a wide low-high temperature range with reduced levels of viscosity modifiers—with lowered deposit forming tendency at high temperatures.

SUMMARY OF THE INVENTION

[0007] In one embodiment, there is provided an engine oil composition meeting SAE J300 requirements comprising (a) a base oil; (b) 0.05 to 40 wt. % of an additive package comprising at least one of a metal detergent, a dispersant, a wear inhibitor, an anti-oxidant, a friction modifier a viscosity modifier, a corrosion inhibitor, a seal swelling agent, a metal deactivator, an anti-foamant, and mixtures thereof; and (e) a sufficient amount of a Pour Point Reducing Blend Component for the engine oil to have a cold crank simulator viscosity at -20° C. of less than 9,000 mPa·s (cP) and a kinematic viscosity at 100° C. as specified according to SAE J300 for the applicable grade. The Pour Point Reducing Blend Component has an average degree of branching within a range of 6.5 to 10 alkyl branches per 100 carbon atoms. In one embodiment, this sufficient amount of Pour Point Reducing Blend Component is between 2 to 30 wt. % of the engine oil composition

[0008] In another aspect, there is provided a method to reduce the use of viscosity modifiers in engine oil compositions meeting SAE J300 requirements, the method includes the step of adding to a base oil typically used for preparing engine oil compositions a sufficient amount of a Point Reducing Blend Component having an average degree of branching within a range of 6.5 to 10 alkyl branches per 100 carbon atoms for the engine oil to have a cold crank simulator viscosity at -20° C. of less than 9000 cP and a kinematic viscosity at 100° C. as specified according to SAE J300 for the applicable grade.

[0009] In yet another aspect of preparing an engine oil composition meeting SAE J300 requirements having a reduced level of viscosity modifiers, the method comprising the steps of blending: (a) 40 to 90 wt. % a base oil; (b) 0.05 to 40 wt. % of an additive package comprising at least one of a metal detergent, a dispersant, a wear inhibitor, an anti-oxidant, a friction modifier, a viscosity modifier, a corrosion inhibitory a seal swelling agent, a metal deactivator, an anti-foamant, and mixtures thereof; with (c) a sufficient amount of a Pour Point Reducing Blend Component having an average degree of branching within a range of 6.5 to 10 alkyl branches per 100 carbon atoms for the engine oil to have a cold crank simulator viscosity at -20° C. of less than 9000 cP and a kinematic viscosity at 100° C. as specified according to SAE J300 for the applicable grade.

DETAILED DESCRIPTION

[0010] The following terms will be used throughout the specification and will have the following meanings unless otherwise indicated.

[0011] As used herein, “multi-grade engine oil” may be used interchangeably with “engine oil”, referring to an engine oil containing a viscosity modifier for it to have viscosity/temperature characteristics which fall with the limits of two different SAE numbers in SAE J300 (revised as of May 2004). For example, 10W40 is a multi-grade engine oil with the “10W” meaning that this oil can be pumped by the engine as well as a single-grade SAE 10 oil can be pumped at the specified low temperature, and the second number, 40, meaning that the viscosity of this multi-grade oil at 100° C. (212° F.) operating temperature corresponds to the viscosity of a single-grade 40 oil at same temperature.

[0012] “Fischer-Tropsch derived” means that the product, fraction, or feed originates from or is produced at some stage by a Fischer-Tropsch process. As used herein, “Fischer-Tropsch base oil” may be used interchangeably with “FT base oil,” “FTBO,” “GTL base oil” (GTL; gas-to-liquid), or “Fischer-Tropsch derived base oil.”

[0013] As used herein, “Pour Point Reducing Blend Component” refers to an isomerized waxy product with relatively high molecular weights and a specified degree of alkyl branching in the molecule, such that it reduces the pour point of lubricating base oil blends containing it. Examples of a pour point reducing blend component are disclosed in U.S. Pat. Nos. 6,150,577 and 7,053,254, and Patent Publication No. US 2005-0247600 A1. A Pour Point Reducing Blend Component can be: 1) an isomerized Fischer-Tropsch derived bottoms product, 2) a bottoms product prepared from an isomerized highly waxy mineral oil, or 3) an isomerized oil having a kinematic viscosity at 100° C. of at least about 8 mm²/s made from polyethylene plastic.

[0014] “Pour point” is a measurement of the temperature at which a sample of base oil will begin to flow under certain carefully controlled conditions, which can be determined, as described in ASTM D 5950-02.

[0015] “Kinematic viscosity” is a measurement in cSt (mm²/s) of the resistance to flow of a fluid under gravity, determined by ASTM D 445 (e2005). “cSt” means centistokes.

[0016] Cold-cranking simulator apparent viscosity (CCS VIS) is a measurement in millipascal seconds, mPa.s (or centipoise (cP)) to measure the viscometric properties of lubricating base oils under low temperature and low shear. CCS VIS can be determined by ASTM D 5293-04.

[0017] Apparent viscosity as determined by MRV (mini rotary viscometer). ASTM D4684-07, with yield stress reported in pascals (Pa) and viscosity reported in mPa.s or centipoise (cP).

[0018] Oxidator BN measures the response of a lubricating oil in a simulated application. High values, or long times to adsorb one liter of oxygen, indicate good stability. Oxidator BN can be measured via a Dornte-type, oxygen absorption apparatus (R. W. Dornte “Oxidation of White Oils,” Industrial and Engineering Chemistry, Vol. 28, page 26, 1936), under 1 atmosphere of pure oxygen at 340° F., time to absorb 1000 ml of O₂ by 100 g. of oil is reported. In the Oxidator BN test, 0.8 ml of catalyst is used per 100 grams of oil. The catalyst is a mixture of soluble metal-naphthenates simulating the average metal analysis of used crankcase oil. The additive package is 80 millimoles of zinc bispolypropylenephenyldithiophosphate per 100 grams of oil.

[0019] Molecular characterizations can be performed by methods known in the art, including Field Ionization Mass Spectroscopy (FIMS) and n-d-M analysis (ASTM D 32308-95 (Re-approved 2005) with normalization). In FIMS, the base oil is characterized as alkanes and molecules with different numbers of unsaturations. The molecules with different numbers of unsaturations may be comprised of cycloparaffins, olefins, and aromatics. If aromatics are present in significant amount, they would be identified as 4-unsaturations. When olefins are present in significant amounts, they would be identified as 1-unsaturations. The total of the 1-unsaturations, 2-unsaturations, 3-unsaturations, 4-unsaturations, 5-unsaturations, and 6-unsaturations from the FIMS analysis, minus the wt % olefins by proton NMR, and minus the wt % aromatics by HPLC-UV is the total weight percent of molecules with cycloparaffinic functionality. If the aromatics content was not measured, it was assumed to be less than 0.1 wt % and not included in the calculation for total weight percent of molecules with cycloparaffinic functionality. The total weight percent of molecules with cycloparaffinic functionality is the sum of the weight percent of molecules with monocycloparaffinic functionality and the weight percent of molecules with multicycloparaffinic functionality.

[0020] “Viscosity index” (VI) is an empirical, unit-less number indicating the effect of temperature change on the kinematic viscosity of the oil. The higher the VI of an oil the lower its tendency to change viscosity with temperature. Viscosity index is measured according to ASTM D 2270-04.

[0021] High temperature high shear rate viscosity (HTHS) is a measure of a fluid’s resistance to flow under conditions resembling highly-loaded journal bearings in fired internal combustion engines, typically 1 million s⁻¹ at 150° C. HTHS viscosity can be measured by ASTM D 5481-04.

[0022] Brookfield viscosity is used to determine the internal fluid-friction of a lubricant during cold temperature operation, which can be measured by ASTM D 2983-04.

[0023] Shear stability is a measure of the amount of viscosity an oil may lose during operation. The shear stability of an oil can be measured by using both ASTM test methods D445-06 and D5275 (R 1998). Shear stability index is a measure of a VI improver’s contribution to an oil’s percentage kinematic viscosity loss. Shear Stability Index (SSI) can be determined using the Kurt Orbahn method (ASTM 6278 R2002).

[0024] “Bosch injector test 90 cycles” test, as used herein, is a test that measures the percent viscosity loss at 100° C. of the engine oil composition when evaluated using the diesel injector apparatus as defined in CEC-L-14-A-79.

[0025] DaimlerChrysler “OM 441LA” engine test is a test developed by the Coordinating European Council (CEC) as the CEC L-52-T-97 test. The test is part of the ACEA lubricant specifications for heavy duty diesel engines E14, E5, E6 and E7, which measures piston deposit formation, liner wear, bore polish, sludge formation, oil consumption and ring sticking.

[0026] The Volkswagen or “VW TDI” test is an important measure of engine lubrication oil quality (piston deposits) under severe conditions, specifically for an in-line passenger car diesel engine.

[0027] The “Panel Coker 1Test” measures the deposit forming tendency of oil at high temperatures. The test apparatus consists of a rectangular stainless steel reservoir, inclined 25 degrees from horizontal. The reservoir is fitted with a machined steel piece fitting integrally into the top of the reservoir, and framing a 95 mm by 45 mm aluminum panel. The test panel is held in place by a hearing element, which is fitted with thermocouple probes to control the temperature of the aluminum test panel. A horizontal shaft, fitted with a series of tines, is positioned above the oil. During rotating of the shaft, the tines sweep through the test lubricant and lubricant droplets are thrown onto the heated aluminum test panel. In the Panel Coker test, the apparatus is assembled forming a closed system and the test panel is heated to a temperature in the range of 260-325° C. The shaft is rotated at 1000 rpm and the test lubricant is splashed onto the heated, weighted test panel. The splashing heated cycle is continued for normally 2-6 hr, from the time the splasher is started. At the end of the specified time period, the heat is removed, the splasher is stopped, and the test panel is allowed to cool. The test panel is washed, reweighed and the amount of deposit is determined. Weight gain of the aluminum test panel (as carbonaceous/heavily oxidized material) is an indication of the lubricant’s performance under high temperature conditions.

[0028] The term “overbased” as used herein refers to alkali metal and alkaline earth metal alkylaryl sulfonates in which the ratio of the number of equivalents of an alkali metal or alkaline earth metal to the number of equivalents of the organic moiety is greater than 1. Low overbased refers to alkali metal or alkaline earth metal alkylaryl sulfonates having a Total Base Number (TBN) greater than 1 and less than 20, medium overbased refers to alkali metal or alkaline earth metal alkylaryl sulfonates having a TBN greater than 20 and less than 200. High overbased refers to alkali metal or alkaline earth metal alkylaryl sulfonates having a TBN greater than 200.

[0029] The term “Total Base Number” or “TBN” as used herein refers to the amount of base equivalent to milligrams of KOH in one gram of sample. Thus, higher TBN numbers reflect more alkaline products, and therefore a greater alkalinity. TBN was determined using ASTM D 2896 test.

[0030] The boiling range distribution of base oil, by wt %, is determined by simulated distillation (SIMDIS) according to ASTM D 6352-04, “Boiling Range Distribution of Petroleum Distillates in Boiling Range from 174 to 700° C. Gas Chromatography.”

[0031] Extent of branching in the Pour Point Reducing Blend Component product refers to the number of alkyl branches in carbons. Branching and branching position can be determined using carbon-13 (^{13}C) NMR according to the following nine-step process. 1) Identify the CH branch centers and the CH_3 branch termination points using the DEPT Pulse sequence (Doddrell, D. T.; D. T. Pegg; M. R. Bendall, *Journal of Magnetic Resonance* 1982, 48, 323ff.). 2) Verify the absence of carbons initiating multiple branches (quaternary carbons) using the APT pulse sequence (Patt, S. L.; J. N. Shoolery, *Journal of Magnetic Resonance* 1982, 46, 55ff.). 3) Assign the various branch carbon resonances to specific branch positions and lengths using tabulated and calculated values known in the art (Lindeman, L. P., *Journal of Qualitative Analytical Chemistry* 43, 1971 1245ff; Netzel,

D. A., et.al., *Fuel*, 60, 1981, 307ff). 4) Estimate relative branching density at different carbon positions by comparing the integrated intensity of the specific carbon of the methyl/alkyl group to the intensity of a single carbon (which is equal to total integral/number of carbons per molecule in the mixture). For the 2-methyl branch, where both the terminal and the branch methyl occur at the same resonance position, the intensity is divided by two before estimating the branching density. If the 4-methyl branch fraction is calculated and tabulated, its contribution to the 4+ methyls is subtracted to avoid double counting. 5) Calculate the average carbon number. The average carbon number is determined by dividing the molecular weight of the sample by 14 (the formula weight of CH_2). 6) The number of branches per molecule is the sum of the branches found in step 4. 7) The number of alkyl branches per 100 carbon atoms is calculated from the number of branches per molecule (step 6) times 100/average carbon number. 8) Estimate Branching Index (BI) by ^1H NMR Analysis, which is presented as percentage of methyl hydrogen (chemical shift range 0.6-1.05 ppm) among total hydrogen as estimated by NMR in the liquid hydrocarbon composition. 9) Estimate Branching proximity (BP) by ^{13}C NMR, which is presented as percentage of recurring methylene carbons—which are four or more carbons away from the end group or a branch (represented by a NMR signal at 29.9 ppm) among total carbons as estimated by NMR in the liquid hydrocarbon composition. The measurements can be performed using an Fourier Transform NMR spectrometer, e.g., one having a magnet of 7.0 T or greater. After verification by Mass Spectrometry, UV or an NMR survey that aromatic carbons are absent, the spectral width for the ^{13}C NMR studies can be limited to the saturated carbon region, 0-80 ppm vs. TMS (tetramethylsilane). Solutions of 25-50 wt. % in chloroform-d1 are excited by 30 degrees pulses followed by a 1.3 sec acquisition time. In order to minimize non-uniform intension data, the broadband proton inverse-gated decoupling is used during a 6 sec delay prior to the excitation pulse and on during acquisition. Samples are doped with 0.03 to 0.05 M Cr (acac)₃ (tris(acetylacetonato)-chromium (III)) as a relaxation agent to ensure fill intensities are observed. The DEPT and APT sequences can be carried out according to literature descriptions with minor deviations described in the Varian or Bruker operating manuals. DEPT is Distortionless Enhancement by Polarization Transfer. The DEPT 45 sequence gives a signal all carbons bonded to protons. DEPT 90 shows CH carbons only. DEPT 135 shows CH and CH_3 up CH_2 180 degrees out of phase (down). APT is attached proton test, known in the art. It allows all carbons to be seen, but if CH and CH_3 are up, then quaternaries and CH_2 are down. The branching properties of the sample can be determined by ^{13}C NMR using the assumption in the calculations that the entire sample was iso-paraffinic. The naphthenes content may be measured using Field Ionization Mass Spectroscopy (FIMS).

[0032] In one embodiment, the engine oil composition comprises a sufficient amount of at least a Pour Point Reducing Blend Component and at least an additive in a matrix of base oil or base oil blends.

[0033] Base Oil Component: The engine oil composition contains a major amount of at least a base oil (or blends thereof) in an amount ranging from 40 to 90 wt. % in one embodiment, from 50 to 80 wt. % in a second embodiment, and from 60 to 75 wt. % in a third embodiment. Base oils

suitable for use in formulating engine oil compositions are selected from any of the synthetic or natural oils or mixtures thereof e.g., the base oils of Groups I-VI as specified in the American Petroleum Institute (API) Base Oil Interchangeability Guidelines (API 1509) and ATIEL Code of Practice for Developing Engine Oils meeting the Requirements of the ACEA Oil Sequences.

[0034] Examples of natural oils include animal oils and vegetable oils (e.g., castor oil, lard oil) and mineral lubricating oils such as liquid petroleum oils and solvent treated or acid-treated mineral lubricating oils of the paraffinic, naphthenic or mixed paraffinic/naphthenic types. Oils derived from coal or shale are also suitable. Further, oils derived from a Fischer-Tropsch process are also suitable.

[0035] Exemplary base oils include polymerized and inter-polymerized olefins. (e.g., polybutylenes, polypropylenes, propylene isobutylene copolymers, etc.); poly(1-hexenes), poly(1-octenes), poly(1-decenes), etc. and mixtures thereof; alkylbenzenes (e.g., dodecylbenzenes, tetradecylbenzenes, dinonylbenzenes, di-(2-ethylhexyl)benzenes, etc.); polyphenyls (e.g., biphenyls, terphenyls, alkylated polyphenyls, etc.); alkylated diphenyl ethers and the derivatives, analogs and homologs thereof, and the like.

[0036] In one embodiment, the base oil comprises at least a synthetic lubricating oil selected from alkylene oxide polymers and interpolymers and derivatives thereof, where the terminal hydroxyl groups have been modified by a process such as esterification or etherification. Examples of these synthetic oils include polyoxyalkylene polymers prepared by polymerization of ethylene oxide or propylene oxide, and the alkyl and aryl ethers of polyoxyalkylene polymers (e.g., methyl-polyiso-propylene glycol ether having a molecular weight of 1000 Daltons or diphenyl ether of poly-ethylene glycol having a molecular weight of 1000 to 1500 Daltons); and mono- and polycarboxylic esters thereof (e.g., acetic acid esters, mixed C₃-C₈ fatty acid esters, ad C₁₃ Oxo acid diester of tetracylene glycol).

[0037] In another embodiment, the base oil comprises at least a synthetic lubricating oil selected from the esters of dicarboxylic acids (e.g., phthalic acid, succinic acid, alkyl succinic acids and alkenyl succinic acids, maleic acid, azelaic acid, suberic acid, sebasic acid, fumaric acid, adipic acid, linoleic acid dimer, malonic acid, alkylmalonic acids, alkenyl malonic acids) with a variety of alcohols (e.g., butyl alcohol, hexyl alcohol, dodecyl alcohol, 2-ethylhexyl alcohol, ethylene glycol, diethylene glycol monoether, propylene glycol). Specific examples of such esters includes dibutyl adipate, di(2-ethylhexyl) sebacate, di-n-hexyl fumarate, dioctyl sebacate, diisooctyl azelate, diisododecyl azelate, dioctyl phthalate, didecyl phthalate, dieicosyl sebacate, the 2-ethylhexyl diester of linoleic acid dimer, and the complex ester formed by reacting one mole of sebacic acid with two moles of tetraethylene glycol and two moles of 2-ethylhexanoic acid and the like.

[0038] Esters useful as synthetic oils also include those made from C₅ to C₁₂ monocarboxylic acids and polyols and polyol esters such as neopentyl glycol, trimethylolpropane, pentaerythritol, dipentaerythritol and tripentaerythritol. Esters are sometimes also useful as additives to improve certain other properties of a finished lubricant.

[0039] In one embodiment, the base oil is a poly-alpha-olefin (PAO). Typically, the poly-alpha-olefins are derived

from monomers having from about 4 to about 30, or from about 4 to about 20, or from about 6 to about 16 carbon atoms. Examples of useful PAOs include those derived from octene, decene, mixtures thereof, and the like, e.g., 4 mm²/s at 100° C. PAOs, 5 mm²/s at 100° C. PAOs, 7 mm²/s at 100° C. PAOs, 8 mm²/s at 100° C. PAOs, etc., and mixtures thereof. In another embodiment, the base oil comprises mixtures of mineral oils with poly-alpha-olefins. In yet another embodiment, the base oil comprises a polyinternal olefin (PIO—a group VI base oil) or mixtures thereof.

[0040] Unrefined, refined and rerefined oils, either natural or synthetic (as well as mixtures of two or more of any of these) of the type disclosed hereinabove can be used as the base oil. Unrefined oils are those obtained directly from a natural or synthetic source without further purification treatment.

[0041] In one embodiment, the engine oil composition employs a base oil that comprises at least one of the base oils described above. In another embodiment, the composition consists essentially of at least one of the base oils (or blends thereof) described above. Various engine oils can be fabricated from the base oil, including but not limited, for example, 0W-30, 5W-30, 0W40, and 5W-40 oils. In one embodiment, the base oil has a viscosity 100° C. of 2 to 15 mm²/s. In another embodiment, the base oil has a viscosity of 5 to 10 cSt at 100° C. In a third embodiment, a viscosity of less than 9 cSt at 100° C.

[0042] Pour Point Reducing Blend Component: The engine oil composition comprises a sufficient amount of at least a Pour Point Reducing Blend Component to allow the level of viscosity index improvers to be reduced significantly, while still meeting cold temperature targets, e.g., for the engine oil composition to have lowered cold cranking simulator viscosity (CCS). In one embodiment, this sufficient amount of Pour Point Reducing Blend Component is between 2-30 wt. % for the engine oil composition to have a CCS of less than 9,000 mm²/s in the range of -15 to -40° C. In another embodiment, this sufficient amount of Pour Point Reducing Blend Component is between 2-30 wt. % for the engine oil composition to have a cold crank simulator viscosity at -20° C. of less than 9000 cP and a kinematic viscosity at 100° C. as specified according to SAE J300 for the applicable grade. In yet another embodiment, the sufficient amount of Pour Point Reducing Blend Component is sufficient for the engine oil composition to have a mini rotary viscometer (MRV) viscosity at -20° C. of less than 60,000 cP. In yet another embodiment, the sufficient amount is between 2-25 wt. %. In a third embodiment, this sufficient amount is between 3 to 20 wt. %. In a fourth embodiment, this amount is less than 15 wt. %. In a fifth embodiment, the amount of Pour Point Reducing Blend Component is greater than 4 wt. %.

[0043] In one embodiment, the Pour Point Reducing Blend Component is an isomerized Fischer-Tropsch derived vacuum distillation bottoms product, which is a high boiling syncrude fraction which has been isomerized under controlled conditions to give a specified degree of alkyl branching in the molecule. Syncrude prepared from the Fischer-Tropsch process comprises a mixture of various solid, liquid, and gaseous hydrocarbons. When the Fischer-Tropsch waxes are converted into Fischer-Tropsch base oils by various processes, such as by hydroprocessing and distilla-

tion, the base oils produced fall into different narrow-cut viscosity ranges. The bottoms that remains after recovering the lubricating base oil cuts from the vacuum column is generally unsuitable for use as a lubricating base oil itself and is usually recycled to a hydrocracking unit for conversion to lower molecular weight products.

[0044] In one embodiment, the Pour Point Reducing Blend Component is an isomerized Fischer-Tropsch derived vacuum distillation bottoms product having an average molecular weight between 600 and 1100 Dalton and an average degree of branching in the molecules between 6.5 and 10 alkyl branches per 100 carbon atoms. Generally, the higher molecular weight hydrocarbons are more effective as the Pour Point Reducing Blend Component than the lower molecular weight hydrocarbons. In one embodiment, a higher cut point in a vacuum distillation unit which results in a higher boiling bottoms material is used to prepare the Pour Point Reducing Blend Component. The higher cut point also has the advantage of resulting in a higher yield of the distillate base oil fractions. In one embodiment, the Pour Point Reducing Blend Component is an isomerized Fischer-Tropsch derived vacuum distillation bottoms product having a pour point that is at least 3° C., higher than the pour point of the distillate base oil it is blended with.

[0045] In one embodiment, the 10 percent point of the boiling range of the Pour Point Reducing Blend Component that is a vacuum distillation bottoms product is between about 850° F.-1050° F. (454-565° C.). In another embodiment, the Pour Point Reducing Blend Component is derived from either Fischer-Tropsch or petroleum products, having a boiling range above 950° F. (510° C.), and contains at least 50 percent by weight of paraffins. In yet another embodiment the Pour Point Reducing Blend Component has a boiling range above 1050° F. (565° C.)

[0046] In another embodiment, the Pour Point Reducing Blend Component is an isomerized petroleum derived base oil containing material having a boiling range above about 1050° F. In one embodiment, the isomerized bottoms material is solvent dewaxed prior to being used as a Pour Point Reducing Blend Component. The waxy product further separated during solvent dewaxing from the Pour Point Reducing Blend Component were found to display excellent improved pour point depressing properties compared to the oily product recovered after the solvent dewaxing.

[0047] In one embodiment, the Pour Point Reducing Blend Component has an average degree of branching in the molecules within the range of from 6.5 to 10 alkyl branches per 100 carbon atoms. In another embodiment, the Pour Point Reducing Blend Component has an average degree of branching within a range of 6.5 to 8 alkyl branches per 100 carbon atoms. In another embodiment, the Pour Point Reducing Blend Component has an average molecular weight between 600-1100 Daltons. In a third embodiment between 700-1000 Daltons. In one embodiment, the Pour Point Reducing Blend Component has a kinematic viscosity at 110° C. of 8-30 mm²/s, with the 10% point of the boiling range of the bottoms falling between about 850-1050° F. In yet another embodiment, the Pour Point Reducing Blend Component has a kinematic viscosity at 100° C. of 15-20 mm²/s and a pour point of -8 to 12° C.

[0048] In another embodiment, the Pour Point Reducing Blend Component is an isomerized oil having a kinematic

viscosity at 100° C. of at least about 8 mm²/s made from polyethylene plastic. In another embodiment, the Pour Point Reducing Blend Component is made from waste plastic. In yet another embodiment the Pour Point Reducing Blend Component is made from a process comprising: pyrolysis of polyethylene plastic, separating out a heavy fraction, hydrotreating the heavy fraction, catalytic isomerizing the hydrotreated heavy fractions and collecting the Pour Point Reducing Blend Component having a kinematic viscosity at 100° C. of at least about 8 mm²/s. In one embodiment, the Pour Point Reducing Blend Component derived from polyethylene plastic has a boiling range above 1050° F. (565° C.), or even a boiling range above 1200° F. (649° C.).

[0049] In one embodiment and in addition to the Pour Point Reducing Blend Component, commercially available pour point depressant additives can be optionally added in an amount from 0.05 to 1 wt. % to optimize the low temperature fluidity of the composition. Examples include C₈-C₁₈ dialkylfumarate vinyl acetate copolymers, wax naphthalene condensation products, maleic anhydride-styrene copolymers, polymethacrylates, polyacrylates, polyacrylamides, condensation products of haloparaffin waxes and aromatic compounds, vinyl carboxylate polymers, and terpolymers of dialkylfumarates, vinyl esters of fatty acids, ethylene-vinyl acetate copolymers, alkyl phenol formaldehyde condensation resins, alkyl vinyl, ethers, olefin copolymers, and mixtures thereof.

[0050] Additional Components: In one embodiment, the engine oil further comprises at least an additive selected from the group of metal detergents, dispersants, wear inhibitors, oxidation inhibitors, friction modifiers, viscosity modifiers, corrosion inhibitors, seal swelling agents, metal deactivators, antifoamers, and mixtures thereof, in a sufficient amount to provide the desired effects. In one embodiment, this sufficient amount is 0.05 to 40 wt. %. In another embodiment, it is between 1 to 35 wt. %. In a third embodiment, from 5 to 25 wt. %.

[0051] In one embodiment, the additives are incorporated as an "additive package." As used herein, the term "additive package" means any combination of additives listed above for engine oil compositions. In one embodiment, the additive package is a commercially available package, added in an amount from about 1.5% to about 30% by weight of the finished composition. In one embodiment the additive package is a commercially available package, e.g., Lubrizol LZ20000 from the Lubrizol Corporation, OLOATTM 55006A, OLOATM 55007, OLOATM 59029 from Chevron Oronite Company LLC, etc.

[0052] Dispersants are generally used to maintain in suspension insoluble materials resulting from oxidations during use, thus preventing sludge flocculation and precipitation or deposition on engine parts. In one embodiment, the composition comprises 0.3 to about 15.0 wt. % of at least a dispersant. In a second embodiment, from 3.0 to about 7.0 wt. % of at least a dispersant. Examples of dispersants include nitrogen-containing ashless (metal-free) dispersants. An ashless dispersant generally comprises an oil soluble polymeric hydrocarbon backbone having functional groups that are capable of associating with particles to be dispersed. Other examples of dispersants include, but are not limited to, amines, alcohols, amides, or ester polar moieties attached to the polymer backbones via bridging groups.

[0053] In one embodiment, the engine oil composition comprises an ashless dispersant selected from oil soluble salts, esters, amino-esters, amides, imides, and oxazolines of long chain hydrocarbon substituted mono and dicarboxylic acids or their anhydrides, thiocarboxylate derivatives of long chain hydrocarbons, long chain aliphatic hydrocarbons having a polyamine attached directly thereto; and Mannich condensation products formed by condensing a long chain substituted phenol with formaldehyde and polyalkylene polyamine. In another embodiment, the composition comprises at least a carboxylic dispersant. Carboxylic dispersants are reaction products of carboxylic acylating agents (acids, anhydrides, esters, etc.) comprising at least 34 and preferably at least 54 carbon atoms with nitrogen containing compounds (such as amines) organic hydroxy, compounds (such as aliphatic compounds including monohydric and polyhydric alcohols, or aromatic compounds including phenols and naphthols), and/or basic inorganic materials. These reaction products include imides, amides, and esters, e.g., succinimide dispersants.

[0054] Other suitable ashless dispersants may also include amine dispersants, which are reaction products of relatively high molecular weight aliphatic halides and amines, preferably polyalkylene polyamines. Other examples may further include "Mannich dispersants," which are reaction products of alkyl phenols in which the alkyl group contains at least 30 carbon atoms with aldehydes (especially formaldehyde) and amines (especially polyalkylene polyamines). In other embodiments, suitable ashless dispersants may even include post-treated dispersants, which are obtained by reacting carboxylic, amine or Mannich dispersants with reagents such as dimercaptothiazoles, urea, thiourea, carbon disulfide, aldehydes, ketones, carboxylic acids, hydrocarbon-substituted succinic anhydrides, nitrile epoxides, boron compounds and the like. Suitable ashless dispersants may be polymeric, which are interpolymers of oil-solubilizing monomers such as decyl methacrylate, vinyl decyl ether and, high molecular weight olefins with monomers containing polar substituents.

[0055] In one embodiment, an ethylene carbonate-treated bissuccinimide derived from a polyisobutylene having a number average molecular weight of about 2300 Daltons is used as the ashless dispersant. In yet another embodiment, the engine oil composition comprises an ethylene-carbonate-treated bissuccinimide dispersant derived from a polyisobutylene succinic anhydride, wherein the polyisobutylene chain has a number average molecular weight of about 2300 Daltons ("PIBSA 2300") in an amount of about 6.5 wt. %.

[0056] Viscosity Index Improvers (Modifiers): The viscosity index of an engine oil base stock can be increased, or improved, by incorporating therein certain polymeric materials that function as viscosity modifiers (VM) or viscosity index improvers (VII). The addition of the Pour Point Reducing Blend Component allows a reduced amount of viscosity index improver(s) to be used (whether present individually or in combination), i.e., a reduction of at least 5% while still allowing the engine oil composition to meet specified viscometric performance. In one embodiment, the reduction in viscosity modifier level is at least 10%, (compared to an engine oil composition without the Pour Point Reducing Blend Component).

[0057] In one embodiment, the engine oil composition further comprises a reduced amount of viscosity modifiers in

an amount of 0.3 to 25 wt. % of the final weight of the engine oil. Examples of viscosity modifiers include polymeric materials having number average molecular weights of from about 5,000 to about 250,000 Daltons. These viscosity modifiers can optionally be grafted with grafting materials such as, for example, maleic anhydride, and the grafted material can be reacted with, for example, amines, amides, nitrogen-containing hetero cyclic compounds or alcohol, to form multifunctional viscosity modifiers (dispersant-viscosity modifiers). In one embodiment, the engine oil composition comprises about 0.3 to 15 wt. % of an ethylene propylene copolymer viscosity index modifier.

[0058] Other examples of viscosity modifiers include star polymers e.g., a star polymer comprising isoprene/styrene/isoprene triblock. Yet other examples of viscosity modifiers include, poly alkyl (meth) acrylates of low Brookfield viscosity and high shear stability, functionalized poly alkyl (meth) acrylates with dispersant properties of high Brookfield viscosity and high shear stability, polyisobutylene having a weight average molecular weight ranging from 700 to 2,500 Daltons and mixtures thereof. In one embodiment, the first poly alkyl (meth) acrylate having a weight average molecular weight of about 125,000 to 225,000 Dalton, a shear stability index (SSI) of 15 or less, a Brookfield viscosity at -40° C. of between about 200,000 to 600,000 cP. In one embodiment, the second poly alkyl (meth) acrylate viscosity modifier has a weight average molecular weight in the range 50,000 to 150,000 Dalton, a shear stability index (SSI) of about 10 or less, and a Brookfield viscosity at -40° C. of between about 10,000 to 30,000 cP. In yet another embodiment the viscosity modifier is a graft copolymer comprising a polymer backbone which has been grafted by reacting the polymer backbone with a reactant comprising N-p-diphenylamine, 1,2,3,6-tetrahydrophthalimide; 4-anilinophenyl methacrylamide; 4-anilinophenyl maleimide; 4-anilinophenyl itaconamide; an acrylate or methacrylate ester of 4-hydroxydiphenylamine; a reaction product of p-aminodiphenylamine or p-alkylaminodiphenylamine with glycidyl methacrylate; a reaction product of p-aminodiphenylamine with isobutyraldehyde, a derivative of p-hydroxydiphenylamine; a derivative of phenothiazine; a vinylogous derivative of diphenylamine.

[0059] Friction Modifiers: In one embodiment, the lubricating oil composition further comprises a sulfur-containing molybdenum compound. Certain sulfur-containing organo-molybdenum compounds are known to modify friction in lubricating oil compositions, while also offering antioxidant and antiwear credits. Examples of oil soluble organo-molybdenum compounds include dithiocarbamates, dithiophosphates, dithiophosphinates, xanthates, thioxanthates sulfides, and the like, and mixtures thereof. In another embodiment, the composition employs a molybdenum succinimide complex as friction modifier in an amount of 0.15 to about 1.5 wt. %. In a third embodiment, the engine oil comprises at least a mono-, di- or triester of a tertiary hydroxyl amine and a fatty acid as a friction modifying fuel economy additive. In another embodiment, the friction modifier is selected from the group of succinamic acid, succinimide, and mixtures thereof. In yet another embodiment, the friction modifier is selected from an aliphatic fatty amine, an ether amine, an alkoxylated aliphatic fatty amine, an alkoxylated ether amine, an oil-soluble aliphatic carboxylic acid, a polyol ester, a fatty acid amide, an imidazoline,

tertiary amine, a hydrocarbyl succinic anhydride or acid reacted with an ammonia or a primary amine and mixtures thereof.

[0060] Seal swelling agents: Seal fixes are also termed seal swelling agents or seal pacifiers. They are often employed in lubricant or additive compositions to insure proper elastomer sealing, and prevent premature seal failures and leakages. In one embodiment, the composition further includes at least a seal swell agent selected from oil-soluble, saturated, aliphatic, or aromatic hydrocarbon esters such as di-2-ethylhexylphthalate, mineral oils with aliphatic alcohols such as tridecyl alcohol, triphosphite ester in combination with a hydrocarbonyl-substituted phenol, and di-2-ethylhexylsebacate.

[0061] Corrosion inhibitors (Anti-corrosive agents): These additives are typically added to reduce the degradation of the metallic parts contained in the engine oil. Examples include zinc dialkyldithiophosphate, phosphosulfurized hydrocarbons and the products obtained by reaction of a phosphosulfurized hydrocarbon with an alkaline earth metal oxide or hydroxide, preferably in the presence of an alkylated phenol or of an alkylphenol thioester. In one embodiment, the rust inhibitor or anticorrosion agents may be a nonionic polyoxyethylene surface active agent. Nonionic polyoxyethylene surface active agents include, but are not limited to, polyoxyethylene lauryl ether, polyoxyethylene higher alcohol ether, polyoxyethylene nonylphenyl ether, polyoxyethylene octylphenyl ether, polyoxyethylene octyl stearyl ether, polyoxyethylene oleyl ether, polyoxyethylene sorbitol monostearate, polyoxyethylene sorbitol mono-oleate, and polyethylene glycol monooleate. Rust inhibitors or anticorrosion agents may also be other compounds, which include, for example, stearic acid and other fatty acids, dicarboxylic acids, metal soaps, fatty acid amine salts, metal salts of heavy sulfonic acid, partial carboxylic acid ester of polyhydric alcohols, and phosphoric esters. In another embodiment, the rust inhibitor is a calcium stearate salt.

[0062] Detergents: In engine oil compositions, metal-containing or ash-forming detergents function both as detergents to reduce or remove deposits and as acid neutralizers or rust inhibitors, thereby, reducing wear and corrosion and extending engine life. Detergents generally comprise a polar head with long hydrophobic tail, with the polar head comprising a metal salt of an acid organic compound.

[0063] In one embodiment, the engine oil composition contains one or more detergents, which are normally salts, e.g., overbased salts. Overbased salts, or overbased materials, are single phase, homogeneous Newtonian systems characterized by a metal content in excess of that which would be present according to the stoichiometry of the metal and the particular acidic organic compound reacted with the metal. In another embodiment, the engine oil composition comprises at least a carboxylate detergents. Carboxylate detergents, e.g., salicylates, can be prepared by reacting an aromatic carboxylic acid with an appropriate metal compound such as an oxide or hydroxide. In yet another embodiment, the engine oil composition comprises at least an overbased detergent. Examples of the overbased detergents include, but are not limited to calcium sulfonates, calcium phenates, calcium salicylates, calcium stearates and mixtures thereof. Overbased detergents may be low overbased (e.g., Total Base Number (TBN) below about 50). Suitable

overbased detergents may alternatively be high overbased (e.g., TBN above about 150) or medium overbased (e.g., TBN between 50 and 150). The lubricating oil compositions may comprise more than one overbased detergents, which may be all low-TBN detergents, all high-TBN detergents, or a mix of those two types. Other suitable detergents for the lubricating oil compositions include "hybrid" detergents such as, for example, phenate/salicylates, sulfonate/phenates, sulfonate/salicylates, sulfonates/phenates/salicylates, and the like. In other embodiments, the composition comprises detergents made from alkyl benzene and fuming sulfonic acid, phenates (high overbased, medium overbased, or low overbased), high overbased phenate stearates, phenolates, salicylates, phosphonates, thiophosphonates, sulfonates, carboxylates, ionic surfactants and sulfonates and the like.

[0064] Oxidation Inhibitors/Antioxidants: Oxidation inhibitors or antioxidants reduce the tendency of mineral oils to deteriorate in service, which deterioration is evidenced by the products of oxidation such as sludge, lacquer, and varnish-like deposits on metal surfaces. In one embodiment, the engine oil composition contains from about 50 ppm to about 5.00 wt. % of at least an antioxidant selected from the group of phenolic antioxidants, aminic antioxidants, or a combination thereof. In other embodiments, the amount of antioxidants is between 0.10 to 3.00 wt. %. In yet other embodiments, ranging from about 0.20 to 0.80 wt. %. An example of an antioxidant used is di-C₈-diphenylamine, in an amount of about 0.05 to 2.00 wt. % of the total weight of the oil composition. Other examples of antioxidants include MoS and Mo oxide compounds.

[0065] Other examples of antioxidants include hindered phenols, alkaline earth metal salts of alkylphenolthioesters having C₅ to C₁₂ alkyl side chains; calcium nonylphenol sulphide; oil soluble phenates and sulfurized phenates; phosphosulfurized or sulfurized hydrocarbons or esters; phosphorous esters; metal thiocarbamates; oil soluble copper compounds known in the art; phenyl naphthyl amines such as phenylene diamine phenothiazine diphenyl amine, diarylamine; phenyl-alphanaphthylamine, 2,2'-diethyl-4,4'-diethyl diphenylamine, 2,2'-diethyl-4-t-octyl diphenylamine; alkaline earth metal salts of alkylphenol thioesters, having C₅ to C₁₂ alkyl side chains, e.g., calcium nonylphenol sulfide, barium t-octylphenol sulfide, zinc dialkyldithiophosphates, dioctylphenylamine, phenylalphanaphthylamine and mixtures thereof. Some of these antioxidants further function as corrosion inhibitors. Other suitable antioxidants which also function as antiwear agents include bis alkyl dithiothiadiazoles such as 2,5-bis-octyl dithiothiadiazole.

[0066] Anti-foamants: In one embodiment, the engine oil further comprises an anti-foamant (foam inhibitor) in amounts ranging from about 5 to about 50 ppm. Examples include alkyl methacrylate polymers, dimethyl silicone polymers, and foam inhibitors of the polysiloxane type, e.g., silicone oil and polydimethyl siloxane for foam control. In another embodiment, the anti-foamant is a mixture of polydimethyl siloxane and fluorosilicone. In yet another embodiment, the engine oil further comprises an acrylate polymer anti-foamant with a weight ratio of the fluorosilicone anti-foamant to the acrylate anti-foamant ranging from about 3:1 to about 1:4. In a fourth embodiment, the engine oil comprises an anti-foam-effective amount of a silicon-containing anti-foamant such that the total amount of silicon in the

engine oil is at least 30 ppm. In yet another embodiment, the silicon-containing antifoam agent is selected from the group consisting of fluorosilicones, polydimethylsiloxane, phenyl-methyl polysiloxane, linear siloxanes, cyclic siloxanes, branched siloxanes, silicone polymers and copolymers, organo-silicone copolymers, and mixtures thereof.

[0067] Anti-wear agents: Anti-wear agents can also be added to the engine oil composition. Representative of suitable antiwear agents are zinc dialkyldithiophosphate, zinc diaryldilhiophosphate, Zn or Me dithiocarbamates, phosphites, amine phosphates, borated succinimide, magnesium sulfonate, and mixtures thereof. In one embodiment, the composition further comprises at least a dihydrocarbyl dithiophosphate metal as antiwear and antioxidant agent in amounts of about 0.1 to about 10 wt. %. The metal may be an alkali or alkaline earth metal, or aluminum, lead, tin, molybdenum, manganese, nickel or copper.

[0068] Some of the above-mentioned additives can provide a multiplicity of effects; thus for example, a single additive may act as a dispersant as well as an oxidation inhibitor. These multifunctional additives are well known. In one embodiment, when the engine oil composition contains one or more of the above-mentioned additives, each additive is typically blended into the base oil in an amount that enables the additive to provide its desired function. It may be desirable, although not essential, to prepare one or more additive concentrates comprising additives (concentrates sometimes being referred to as "additive packages") whereby several additives can be added simultaneously to the oil to form the end oil composition. The final composition may employ from about 0.5 to about 30 wt. % of the concentrate, the remainder being the oil of lubricating viscosity. The components can be blended in any order and can be blended as combinations of components.

[0069] Method for Making: The Pour Point Reducing Blend Component and other additives can be blended into the base oil matrix individually or in various sub-combinations. In one embodiment, all of the components are blended concurrently as an additive concentrate, or additives plus a diluent, such as a hydrocarbon solvent. The use of an additive concentrate takes advantage of the mutual compatibility afforded by the combination of ingredients when in the form of an additive concentrate. In another embodiment, the engine oil composition is prepared by mixing the base oil and the pour point depressant with the separate additives or additive package(s) at an appropriate temperature, e.g., 60° C., until homogeneous.

[0070] Applications: Among other things, the engine oil composition resists viscosity shear and is formulated with a lower level of viscosity modifiers for excellent protection of gears, bearings, cam lobes, cam followers, and other high-pressure components in engines and transmissions.

[0071] The composition delivers lubrication in all types of automotive and commercial vehicles gasoline and diesel engines, gasoline fueled four-stroke outboard, inboard, inboard/outboard (I/O) and personal watercraft motors, including but not limited to large and small gasoline or diesel engines in cars, motorcycles trucks, motor homes, maintenance equipment, heavy equipment, street rods, military, and marine applications.

[0072] Properties: The engine oil composition is characterized as meeting SAE specifications, API specifications

(API 1509) as well as the ACEA Specifications for service fill oils for gasoline and diesel engines. In another embodiment, the engine oil composition meets the specifications for SAE J300 viscosity grade 0W-XX, 5W-XX, 10W-XX, 15W-XX, 20W-XX, or 25W-XX engine oil, wherein XX represents the integer 20, 30, 40, 50 or 60. In yet another embodiment the multi-grade engine oil meets the SAE specifications, API specifications (API 1509) as well as the ACEA Specifications.

[0073] In one embodiment, the engine oil composition is characterized as meeting the requirements of SAE J300 over a wide temperature range while still having a low level of viscosity modifiers. Depending on the diluted factor of the viscosity modifiers used, this amount may range from 0.3 to 25 wt. %. In one embodiment, the reduced amount of viscosity modifiers is less than 10 wt. %. In a second embodiment, the engine oil composition meeting SAE J300 requirements contains less than 7.5 wt. % viscosity modifiers. In a third embodiment, the engine oil composition meeting SAE J300 requirements contains less than 5 wt. % viscosity modifiers.

[0074] The engine oil composition is further characterized as having a reduced deposit-formation tendency (as shown, for example, using the Panel Coker Test and compared with compositions without the Pour Point Reducing Blend Component) with a reduced level of viscosity index modifiers. The amount of viscosity index modifier is reduced at least 10% in one embodiment (compared to a composition without the sufficient amount of a Pour Point Reducing Blend Component). In one embodiment, the amount of reduced level of viscosity index modifier is less than 2 wt. %, less than 1.5 wt. % in a second embodiment, and less than 1.25 wt. % in a third embodiment.

[0075] As the engine oil composition contains less viscosity index improvers, it also has a reduced tendency to form engine deposits. In one embodiment, the composition forms at least 10% less deposit (as tested under the Panel Coker Test) as compared to a comparable composition without the sufficient amount of Pour Point Reducing Blend Component. In yet another embodiment, the composition forms at least 25% less deposit than a comparable composition without the Pour Point Reducing Blend Component. In a third embodiment, the reduction in the deposit is at least 50% less.

[0076] Viscometrics is an important lubricant parameter that governs the successful operation of engine oils. In one embodiment, the engine oil composition comprising the Pour Point Reducing Blend Component has an apparent viscosity of 60,000 cP or less in MRV test (ASTM D4684-07@30° C.) and a yield stress of less than 35 Pa (as measured per ASTM D4684-89@-30° C.).

[0077] In yet another embodiment, the engine oil composition has a kinematic viscosity at 100° C. as specified according to SAE J300 for the applicable grade. In one embodiment, the engine oil composition has a cold crank simulator viscosity at -20° C. of less than 9000 cP, and less than 7500 cP in a second embodiment. In one embodiment, the engine oil composition has a mini rotary viscosity at -30° C. of less than 60000 cP and a yield stress of less than 35 Pa (as measured per ASTM D4684-07@-30° C.).

[0078] In one embodiment, the composition has a kinematic viscosity at 100° C. between 3.5 and 25 mm²/s. In a second embodiment a kinematic viscosity at 100° C. between 13.50 and 20 mm²/s.

EXAMPLES

[0079] The following examples are given as non-limitative illustration of aspects of the invention. Unless specified otherwise, the components in the examples are as follows (and expressed as wt. % in the Tables):

[0080] Pour Point Reducing Blend Component (PPRBC-FTBO) is from Chevron Corporation of San Ramon, Calif. The properties are as listed in Table 4.

[0081] XOM 150N and 600N are Group I base stocks from ExxonMobil Corporation.

[0082] NESTETM 3050, 3080 and 3043XV are Group III base oil stocks from Neste Oil Corporation, NESTETM 3043, 3050 and 3080 have properties as follows:

TABLE 1

| Property | Typical value NESTE™ 3043 | Typical value NESTE™ 3050 | Typical value NESTE™ 3080 |
|--|---------------------------------|---------------------------------|---------------------------------|
| Viscosity @ 40° C., cSt (mm ² /s) | 20-21 | 26 | 50 |
| Viscosity @ 100° C., cSt (mm ² /s) | 4.2-4.4 | 5.1 | 8.0 |
| Viscosity index | >121 | 126 | 128 |
| Pour point, °C. | -18 | -15 | -15 |
| Flash point, °C. | 224 | 240 | 260 |

TABLE 1-continued

| Property | Typical value NESTE™ 3043 | Typical value NESTE™ 3050 | Typical value NESTE™ 3080 |
|-----------------------------|---------------------------------|---------------------------------|---------------------------------|
| Color (ASTM D- 1500-04a) | <0.5 | <0.5 | <0.5 |
| Noack volatility, w % | 14.4 | <=8.4 | <=3.5 |
| Density at 15° C. | 831 | 835 | 843 |

[0083] XOA3161F, OLOA™ 4594HA, and OLOA™ 59912 are additive packages from Chevron Oronite of San Ramon, Calif.

[0084] OLOA™ 2509Z and 19803 are pour point depressants from Chevron Oronite.

[0085] PARATONE™ 8071 and PARATONE™ 8900 are viscosity index improvers from Chevron Oronite.

EXAMPLES 1-4

[0086] The components in Table 2 were blended together and their properties were measured. The results are also shown in Table 2.

[0087] The results establish that the addition of the Pour Point Reducing Blend Component allows up to 20% reduction in the viscosity modifier (VM) content, with low temperature performance remaining essentially similar to samples with a high VM content. Low VM content is key in European engine deposit tests.

TABLE 2

| All examples are 10W40 blends | Example 1 | Example 2 | Example 3 | Example 4 |
|--|-----------|-----------|-----------|-----------|
| Base stock NEXBASE 3050, wt. % | 48.87 | 52.61 | 58.27 | 61.34 |
| Base stock NEXBASE 3080, wt. % | 26.9 | 19.46 | 11.10 | 5.33 |
| PPRBC - FTBO, wt. % | 0 | 4.00 | 7.00 | 10.00 |
| XOA3161F Additive, wt. % | 19.4 | 19.4 | 19.4 | 19.4 |
| PARATONE 8071, wt. % | 4.90 | 4.60 | 4.30 | 4.00 |
| | =100% | =93.9% | =87.9% | =81.6% |
| Kinematic Viscosity @ 40° C., mm ² /s | — | — | — | — |
| Kinematic Viscosity @ 100° C., mm ² /s | 14.01 | 14.03 | 13.82 | 13.76 |
| CCS at -25° C. | 6767 | 6852 | 6795 | 6868 |
| Mini Rotary Viscosimeter | | | | |
| Viscosity cP (max 60,000) ASTM D4684 @ -30° C. | 27400 | 35000 | 23900 | 24900 |
| Yield Stress, Pa (max <= 35 Pa) ASTM D4684@ -30° C. | <=35 | <=35 | <=35 | <=35 |
| Pour Point, °C. | -30 | -30 | -30 | -30 |
| Bosch injector test 90 cycles, % loss | 5.92 | 6.13 | 5.72 | 5.60 |
| CEC-L-14-A-79 | | | | |
| Sheared oil at 100° C., mm ² /s ASTM D445 | 13.18 | 13.17 | 13.03 | 12.99 |

EXAMPLES 5-8

[0088] The components in Table 3 were blended together and their properties were measured. The results are shown in Table 3.

[0089] As shown, the addition of the Pour Point Reducing Blend Component allows a reduction in the viscosity modifier. There is also significantly less deposit build-up with the reduced amount of viscosity modifier used.

TABLE 3

| Components in wt. % | Example 5 10W40 | Example 6 10W40 | Example 7 15W50 | Example 8 15W50 |
|---|--------------------|--------------------|--------------------|--------------------|
| NEXBASE 3043XV | 40 | 30 | — | — |
| XOM 150N | 28.96 | 41.55 | 69.72 | 63.06 |
| XOM 600N | 14.92 | 2.65 | 19.09 | 16.26 |
| PPRBC - FTBO, wt. % | — | 10 | — | 10 |
| OLOA 4594HA | 14.7 | 14.7 | — | — |
| OLOA 59912 | — | — | 9.50 | 9.50 |
| OLOA 2509Z | — | — | 0.40 | — |
| OLOA 19803 | 0.30 | — | — | — |
| Paratone 8900, wt. % | 1.12 = 100% | 1.10 = 98.2% | 1.29 = 100% | 1.18 = 91.4% |
| Kinematic Viscosity @ 40° C., mm ² /s | 102.9 | 102 | — | — |
| Kinematic Viscosity @ 100° C., mm ² /s | 15.51 | 15.49 | 18.24 | 18.32 |
| CCS at -20° C. | — | — | 7140 | 7200 |
| CCS at -25° C. | 7150 | 7090 | — | — |
| HTHS viscosity, cP | 4.48 | 4.51 | 4.80 | 4.92 |
| ASTM D5481 | — | — | — | — |
| Panel Coker Deposit - mg., average from 4 panels | 519.9 | 371.0 | 271.6 | 138.6 |

[0090]

TABLE 4

| Properties | PPRBC - FTBO |
|---|--------------|
| Kinematic Viscosity @ 40° C., cSt (mm ² /s) | 106.4 |
| Kinematic Viscosity @ 100° C., cSt (mm ² /s) | 16.01 |
| Viscosity Index | 161 |
| Cold Crank Viscosity @ -30° C., cP | 46,991 |
| Cold Crank Viscosity @ -25° C., cP | 18,905 |
| Pour Point, °C. | -10 |
| n-d-m (ASTM D3238-95 Reapproved 2005) with normalization to 100% total wt % carbon) | — |
| Molecular Weight, gm/mol (VPO) | 743 |
| Density, gm/ml | 0.8330 |
| Refractive Index | 1.4641 |
| Paraffinic Carbon, % | 92.98 |
| Naphthenic Carbon, % | 7.02 |
| Aromatic Carbon, % | 0.00 |
| Oxidator BN, hrs | 45.32, 43.95 |
| Noack, wt. % | 0.95 |
| Total Aromatics, wt % by HPLC UV | 0.03062 |
| SIMDIST TBP (WT %), F (ASTM D-6352-04) | — |
| TBP @0.5 | 915 |
| TBP @5 | 963 |
| TBP @10 | 988 |
| TBP @20 | 1011 |
| TBP @30 | 1040 |
| TBP @40 | 1057 |
| TBP @50 | 1074 |
| TBP @60 | 1092 |
| TBP @70 | 1113 |
| TBP @80 | 1141 |

TABLE 4-continued

| Properties | PPRBC - FTBO |
|-----------------------------------|--------------|
| TBP @90 | 1181 |
| TBP @95 | 1213 |
| TBP @99.5 | 1290 |
| FIMS by Probe sample introduction | tof556 |

TABLE 4-continued

| Properties | PPRBC - FTBO |
|--------------------------------|--------------|
| Saturates | 65.4 |
| 1-Unsaturation | 33.1 |
| 2-Unsaturation | 1.2 |
| 3-Unsaturation | 0.3 |
| 4-Unsaturation | 0 |
| 5-Unsaturation | 0 |
| 6-Unsaturation | 0 |
| NMR Analysis: | — |
| Branching Index | 20.83 |
| Branching Proximity | 27.05 |
| Alkyl Branches per Molecule | 4.02 |
| FCI | 14.36 |
| Alkyl Branches per 100 Carbons | 7.58 |

[0091] For the purpose of this specification and appended claims, unless otherwise indicated, all numbers expressing quantities, percentages or proportions, and other numerical values used in the specification and claims, are to be understood as being modified in all instances by the term "about." Accordingly, unless indicated to the contrary, the numerical parameters set forth in the following specification and attached claims are approximations that may vary depending upon the desired properties sought to be obtained and/or the precision of an instrument for measuring the value, thus including the standard deviation of error for the device or method being employed to determine the value. The use of the term "or" in the claims is used to mean "and/or" unless explicitly indicated to refer to alternatives only or the alternative are mutually exclusive, although the

disclosure supports a definition that refers to only alternatives and "and/or." The use of the word "a" or "an" when used in conjunction with the term "comprising" in the claims and/or the specification may mean "one," but it is also consistent with the meanings of "one or more," "at least one," and "one or more than one." Furthermore, all ranges disclosed herein are inclusive of the endpoints and are independently combinable. In general, unless otherwise indicated, singular elements may be in the plural and vice versa with no loss of generality. As used herein, the term "include" and its grammatical variants are intended to be non-limiting, such that recitation of items in a list is not to the exclusion of other like items that can be substituted or added to the listed items.

[0092] It is contemplated that any aspect of the invention discussed in the context of one embodiment of the invention may be implemented or applied with respect to any other embodiment of the invention. Likewise, any composition of the invention may be the result or may lie used in any method or process of the invention. This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to make and use the invention. The patentable scope is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims. All citations referred herein are expressly incorporated herein by reference.

1. An engine oil composition meeting SAE J300 requirements comprising: (a) a base oil selected from a natural oil, a synthetic oil, and mixtures thereof, (b) 0.05 to 40 wt % of at least an additive selected from the group of metal detergents, dispersants, wear inhibitors, anti-oxidants, friction modifiers, viscosity modifiers, corrosion inhibitors, seal swelling agents, metal deactivators, anti-foamants, and mixtures thereof; (c) a sufficient amount of a Pour Point Reducing Blend Component for the engine oil composition to have a cold crank simulator at -20° C. of less than 9000 cP and a kinematic viscosity at 100° C. as specified according to SAE J330;

wherein the Pour Point Reducing Blend Component has an average degree of branching within a range of 6.5 to 10 alkyl branches per 100 carbon atoms.

2. The composition of claim 1, wherein the Pour Point Reducing Blend Component has an average degree of branching within a range of 6.5 to 8 alkyl branches per 100 carbon atoms.

3. The composition of claim 1, wherein the sufficient amount of Pour Point Reducing Blend Component ranges from 2 to 30 wt % of the engine oil composition.

4. The composition of claim 3, wherein the sufficient amount of Pour Point Reducing Blend Component ranges from 3 to 20 wt %.

5. The composition of claim 4, wherein the sufficient amount of Pour Point Reducing Blend Component ranges from 4 to 15 wt %.

6. The composition of claim 1, wherein the base oil is selected from the group of a mineral oil, a vegetable oil, an oligomer of an alphaolefin, an ester, an oil derived from a Fischer-Tropsch process, and mixtures thereof.

7. The composition of claim 5, wherein the base oil is one of a poly-alpha-olefin, an ester base oil, or mixtures thereof.

8. The composition of claim 1, wherein the Pour Point Reducing Blend Component is selected from an isomerized Fischer-Tropsch derived bottoms product, a bottoms product prepared from an isomerized highly waxy mineral oil, an isomerized oil having a kinematic viscosity at 100° C. of at least about 8 mm²/s made from polyethylene plastic and mixtures thereof.

9. The composition of claim 1, wherein the Pour Point Reducing Blend Component has an average molecular weight between 600-100 Daltons.

10. The composition of claim 1, wherein the Pour Point Reducing Blend Component has a kinematic viscosity at 100° C. of 8-22 (mm²/s) with a 10% point of the boiling range of the Pour Point Reducing Blend Component falling between about 850-1050° F.

11. The composition of claim 1, wherein the Pour Point Reducing Blend Component has a pour point of -8 to -12° C.

12. The composition of claim 1, wherein the composition comprises less than 15 wt % of a viscosity index modifier.

13. The composition of claim 1, wherein the composition comprises less than 10 wt % of a viscosity index modifier.

14. The composition of claim 12, wherein the composition comprises less than 5 wt % of a viscosity index modifier.

15. The composition of claim 1, wherein the composition contains at least 10% less viscosity index modifier compared to a comparable engine oil composition without the sufficient amount of Pour Point Reducing Blend Component.

16. The composition of claim 1, wherein the composition results in at least 10% less deposit under the Panel Coker Test compared to a comparable composition without the sufficient amount of Pour Point Reducing Blend Component.

17. The composition of claim 15, wherein the composition results in at least 25 % less deposit under the Panel Coker Test compared to a comparable composition without the sufficient amount of Pour Point Reducing Blend Component.

18. The composition of claim 16, wherein the composition results in at least 50% less deposit under the Panel Coker Test compared to a comparable composition without the sufficient amount of Pour Point Reducing Blend Component.

19. The composition of claim 1, wherein the composition is for use in a gasoline engines, diesel engines, motorcycles, trucks, motor homes, maintenance equipment, heavy equipment, street rods, military applications, and personal watercraft motors.

20. A method to reduce the use of a viscosity index modifier in engine oil compositions meeting SAE J300 requirements, the method comprising adding to a base oil typically used for preparing engine oil compositions a sufficient amount of a Pour Point Reducing Blend Component having an average degree of branching within a range of 6.5 to 10 alkyl branches per 100 carbon atoms for the engine oil to have a cold crank simulator viscosity at -20° C. have a cold crank simulator viscosity at -20° C. of less than 9000 cP and a mini rotary viscometer (MRV) viscosity at -20° C. of less tan 60,000 cP.

21. The method of claim 19, wherein the sufficient amount of the Pour Point Reducing Blend Component ranges from 2 to 30 wt. % of the engine oil composition.

22. The method of claim 19, wherein the base oil typically used for preparing engine oil compositions is selected from the group of a mineral oil a vegetable oil, an oligomer of an alphaolefin, an ester, an oil derived from a Fischer-Tropsch process, and mixtures thereof.

23. A method for preparing engine oil compositions meeting SAE J300 requirements, the method comprising blending into a mixture of: (a) 40 to 90 wt. % a base oil; (b) 0.05 to 40 wt. % of at least an additive selected from the group of metal detergents, dispersants, wear inhibitors,

anti-oxidants, friction modifiers, viscosity modifiers, corrosion inhibitors, seal swelling agents, metal deactivators, anti-foamants, and mixtures thereof, and (c) a sufficient amount of a Pour Point Reducing Blend Component having an average degree of branching within a range of 6.5 to 10 alkyl branches per 100 carbon atoms for the engine oil to have cold crank simulator viscosity at -20° C. of less than have a cold crank simulator viscosity at -20° C. of less than 9000 cP and a mini rotary viscometer (MRV) viscosity at -20° C. of less than 60,000 cP.

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