

LUBRICANT COMPOSITIONS WITH LOW HTHS FOR A GIVEN SAE VISCOSITY GRADE

5 FIELD OF THE INVENTION

The present invention relates to lubricant compositions which exhibit certain performance characteristics; particularly a low High-Temperature, High-Shear viscosity measurement.

10 BACKGROUND OF THE INVENTION

Lubricant compositions are well known in the art. Lubricant compositions are typically made up of base oil and various additives. Lubricant compositions must meet specific performance characteristics such as, but not limited to, kinematic viscosity and High-Temperature, High-Shear viscosity measurement (HTHS),
15 depending on their end use.

It is known in the art that fuel economy of vehicles and the HTHS values of the lubricant composition used in the vehicle are related. Vehicles using lubricant compositions having lower HTHS values exhibit improved fuel economy. For every SAE Viscosity Grade, a minimum HTHS of the lubricant composition is specified in
20 the SAE J300 Engine Oil Viscosity Classification. Therefore, a lubricant composition that has an HTHS that is at or near the minimum required for the SAE Viscosity Grade is expected to provide the best fuel economy.

The present invention provides a lubricant composition comprising base oil having a viscosity index equal to or greater than 120 that exhibits an HTHS at or near
25 the minimum for its SAE Viscosity Grade. The present invention is a lubricant composition comprising base oil having a viscosity index equal to or greater than 120 and a first polymer having a kinematic viscosity ratio less than or equal to 0.25 and a shear stability index (SSI) equal to or greater than 20 percent.

30 SUMMARY OF THE INVENTION

In a non-limiting embodiment, the present invention is a lubricant composition comprising: a first polymer having a kinematic viscosity as defined later in the specification ratio less than or equal to 0.25 and a shear stability index (SSI) equal to

or greater than 20 percent; and a base oil having a viscosity index equal to or greater than 120.

In another non-limiting embodiment, the present invention is a lubricant composition comprising: a polymer having a kinematic viscosity ratio less than or
5 equal to 0.25 and a shear stability index (SSI) equal to or greater than 20 percent; and a base oil having a viscosity index equal to or greater than 120, wherein the concentration of phosphorus in the lubricant composition is less than 0.08 weight percent and the concentration of sulfur is less than 0.5 weight percent.

10 **DETAILED DESCRIPTION OF THE INVENTION**

Unless otherwise indicated, all numbers expressing quantities of ingredients, reaction conditions, dimensions, physical characteristics, processing parameters, and the like, 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
15 numerical values set forth in the following specification and claims may vary depending upon the desired properties sought to be obtained by the present invention. At the very least, and not as an attempt to limit the application of the doctrine of equivalents to the scope of the claims, each numerical value should at least be construed in light of the number of reported significant digits and by applying
20 ordinary rounding techniques. Moreover, all ranges disclosed herein are to be understood to encompass the beginning and ending range values and any and all subranges subsumed therein. For example, a stated range of "1 to 10" should be considered to include any and all subranges between (and inclusive of) the minimum value of 1 and the maximum value of 10; that is, all subranges beginning with a
25 minimum value of 1 or more and ending with a maximum value of 10 or less, e.g., 5.5 to 10. Any mentioning of a U.S. Patent or patent document or literature reference in the following description also incorporates by reference that document herein and is to be understood to be incorporated in its entirety.

The following terms used herein are defined below.

- 30 (A) base oil- mixtures of one or more basestocks.
(B) kinematic viscosity- temperature specific property measured according to ASTM D445.

(C) kinematic viscosity ratio of a polymer- the kinematic viscosity of the polymer in solution at 150°C (kv150) divided by the kinematic viscosity of the polymer in solution at 100°C (kv100). The polymer in solution is prepared by diluting the viscosity modifier concentrate in an API Group I solvent neutral 100 base stock
5 between 60°C and 70°C for 45 minutes. The kv100 and kv150 are measured according to ASTM D445.

Table 1 below shows the composition of three different polymer concentrates in solution as used herein as well as the kv100, kv150 and the kinematic viscosity ratios of the polymer solutions. The three polymer concentrates are commercially
10 available. Polymer Concentrate 1 is commercially available from Infineum USA as SV145; Polymer Concentrate 2 is commercially available from Infineum USA as SV265; and Polymer Concentrate 3 is commercially available from Chevron Corporation as Paratone 8451.

Table 1

Component	Polymer Concentrate in Solution 1	Polymer Concentrate in Solution 2	Polymer Concentrate in Solution 3
Polymer Concentrate 1	24.4		
Polymer Concentrate 2		23.0	
Polymer Concentrate 3			27.0
API Group I solvent neutral 100 basestock	75.6	77.0	73.0
<u>Performance</u>			
kv100 [cSt]	30.48	30.50	29.96
kv150 [cSt]	4.65	12.44	11.65
kv150/kv100	0.15	0.41	0.39

- (D) CCS at -30°C [cp]- measured according to ASTM D5293.
- (E) HTHS at 150°C [cp]- measured according to ASTM D4741.
- (F) Shear Stability Index- determined according to ASTM D6278.

(G) thickening efficiency-

$$TE = \frac{1}{c} \frac{\ln(2)}{2} \ln \left(\frac{kv_{polymer+oil}}{kv_{oil}} \right)$$

5

where c is wt% polymer, kv(polymer + oil) is kv100 of the polymer solution, and kv(oil) is kv100 of the oil. kv is measured according ASTM D445.

Various groups of base oils and basestocks are discussed herein. Definitions for the basestocks are the same as those found in the American Petroleum Institute
10 (API) publication "Engine Oil Licensing and Certification System", Industry Services Department, Fourteenth Edition, December 1996, Addendum 1, December 1998.

The present invention is a lubricant composition comprising base oil having a viscosity index ranging of equal to or greater than 120 and a first polymer having a kinematic viscosity ratio less than or equal to 0.25 and a shear stability index (SSI)
15 equal to or greater than 20 percent.

In a non-limiting embodiment of the invention, the base oil comprises a Group III basestock. Group III basestocks contain greater than or equal to 90 percent saturates and less than or equal to 0.03 percent sulfur and have a viscosity index greater than or equal to 120. In another non-limiting embodiment of the invention,
20 the base oil comprises a Group IV basestock. In yet another non-limiting embodiment of the invention, the base oil comprises a Group III basestock and a Group IV basestock. In another non-limiting embodiment of the invention, the base oil comprises Group IV and Group V basestocks. In yet another non-limiting embodiment of the invention, the base oil comprises Group II, Group IV and Group V
25 basestocks.

In a non-limiting embodiment of the invention, the basestock is made using gas-to-liquids ("GTL") process. GTL is a refinery process used to convert natural gas or other gaseous hydrocarbons into longer-chain hydrocarbons. For example, GTL can be used to convert methane-rich gases into liquid fuels either via direct
30 conversion or via syngas as an intermediate using the Fischer Tropsch process. As is well known in the art, isomerization catalyst can be used with GTL to make Group III basestock.

According to the present invention, the lubricant composition comprises at least one polymer (a "first polymer") having a kinematic viscosity ratio less than or equal to 0.25 and a shear stability index (SSI) equal to or greater than 20 percent, for example, equal to or greater than 35 percent or equal to or greater than 45 percent.

5 In a non-limiting embodiment of the invention, the first polymer comprises a minimum of 5 weight percent styrene.

In yet another non-limiting embodiment of the invention, the first polymer has a thickening efficiency (TE) equal to or greater than 2.0, for example, equal to or greater than 2.4 or equal to or greater than 2.8.

10 In a non-limiting embodiment of the invention, suitable first polymers comprise a normal block copolymer (i.e., true block copolymer) or a random block copolymer. The normal block copolymer can be made from (1) conjugated dienes having from 4 to 10 carbon atoms, for example, from 4 to 6 carbon atoms or (2) from vinyl substituted aromatics having from 8 to 12 carbon atoms, for example, 8 or 9
15 carbon atoms.

In a non-limiting embodiment of the invention, the block copolymer is made from conjugated dienes. Suitable conjugated dienes include piperylene, 2,3-dimethyl-1,3-butadiene, chloroprene, isoprene and 1,3-butadiene, with isoprene and 1,3-butadiene being particularly preferred. Mixtures of such conjugated dienes are useful.

20 In another non-limiting embodiment of the invention, the block copolymer is made from vinyl substituted aromatics. Suitable vinyl substituted aromatics include styrene, alpha-methylstyrene, ortho-methylstyrene, meta-methylstyrene, para-methylstyrene, para-tertiary-butylstyrene.

In a non-limiting embodiment of the invention, the normal block copolymers
25 has a total of from 2 to 5, for example, from 2 or 3, polymer blocks of the vinyl substituted aromatic and the conjugated diene with at least one polymer block of said vinyl substituted aromatic and at least one polymer block of said conjugated diene being present. The conjugated diene block is hydrogenated as more fully set forth hereinbelow. The normal block copolymers can be linear block copolymers wherein a
30 substantially long sequence of one monomeric unit (Block I) is linked with another substantially long sequence of a second (Block II), third (Block III), fourth (Block IV), or fifth (Block V) monomeric unit.

The following references disclose suitable copolymers and are hereby incorporated by reference: US 5,429,758; US 5,429,758.

In this embodiment, the vinyl substituted aromatic content of these copolymers (i.e., the total amount of vinyl substituted aromatic blocks in the normal
5 block copolymer) is in the range of from 20 percent to 70 percent by weight, for example, from 40 percent to 60 percent by weight. Thus, the aliphatic conjugated diene content (i.e., the total diene block content) of these copolymers is in the range of from 30 percent to 80 percent by weight, for example, from 40 percent to 60 percent by weight.

10 The described normal block copolymers can be prepared by conventional methods which are well known in the art. In a non-limiting embodiment of the invention, the copolymers are prepared by anionic polymerization using, for example, an alkali metal hydrocarbon (e.g., sec-butyllithium) as a polymerization catalyst.

A commercial example of a normal block copolymer as described above is
15 Infineum SV140 which is a hydrogenated styrene-isoprene block available from Infineum U.S.A (Linden, NJ).

Typically, the polymers of the invention will be introduced into lubricant compositions in the form of a concentrate as is well known in the art. Concentrates comprise one or more components in oil. Typical concentrates contain from 3 to 25
20 weight percent of the polymer.

In a non-limiting embodiment of the invention, the composition comprises more than one polymer. In this embodiment, the composition comprises a first polymer as described above and a "second polymer". Suitable examples of the second polymer include, but are not limited to, olefin polymers such as polybutene;
25 hydrogenated polymers and copolymers and terpolymers of styrene with isoprene and/or butadiene; polymers of alkyl acrylates or alkyl methacrylates; copolymers of alkyl methacrylates with N-vinyl pyrrolidone or dimethylaminoalkyl methacrylate; post-grafted polymers of ethylenepropylene with an active monomer such as maleic anhydride; styrene-maleic anhydride polymers post-reacted with alcohols and amines.
30 These can be used to provide the desired viscosity in the lubrication composition.

According to the present invention, lubricant compositions for specific SAE Viscosity Grades exhibit lower HTHS values closer to the minimum HTHS than conventional lubricant compositions for that Grade. For example, the minimum

HTHS for a 5W30 lubricant composition is 2.9. See Table 2 below for the SAE Engine Oil Viscosity Requirements Classifications which include minimum HTHS requirements.

Table 2. SAE J300 Engine Oil Viscosity Requirements

SAE Viscosity Grades For Engine Oils ⁽¹⁾⁽²⁾					
SAE Viscosity Grade	Low Temperature (°C) Cranking Viscosity ⁽³⁾ , cP Max	Low Temperature (°C) Pumping Viscosity ⁽⁴⁾ , cP Max with No Yield Stress ⁽⁴⁾	Low-Shear-Rate Kinematic Viscosity ⁽⁵⁾ (cSt) at 100°C Min	Low-Shear-Rate Kinematic Viscosity ⁽⁵⁾ (cSt) at 100°C Max	High-Shear-Rate Viscosity ⁽⁶⁾ (cP) at 150°C Min
0W	6200 at -35	60000 at -40	3.8	-	-
5W	6600 at -30	60000 at -35	3.8	-	-
10W	7000 at -25	60000 at -30	4.1	-	-
15W	7000 at -20	60000 at -25	5.6	-	-
20W	9500 at -15	60000 at -20	5.6	-	-
25W	13000 at -10	60000 at -15	9.3	-	-
20	-	-	5.6	< 9.3	2.6
30	-	-	9.3	< 12.5	2.9
40	-	-	12.5	< 16.3	2.9 (0W-40, 5W-40, 10W-40 grades)
40	-	-	12.5	< 16.3	3.7 (15W-40, 20W-40, 25W-40, 40 grades)
50	-	-	16.3	< 21.9	3.7
60	-	-	21.9	< 26.1	3.7

⁽¹⁾ Notes-1cP = 1mPa·s; 1 cSt = 1mm²/S

⁽²⁾ All values are critical specifications as defined by ASTM D3244 (see text, Section 3).

⁽³⁾ ASTM D5293

⁽⁴⁾ ASTM D4684: Note that the presence of any yield stress detectable by this method constitutes a failure regardless of viscosity.

⁽⁵⁾ ASTM D445

⁽⁶⁾ ASTM D4683, CEC L-36-A-90 (ASTM D4741) or D5481

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The lubricant composition of the present invention encompasses different SAE J300 viscosity grades. In various non-limiting embodiments, the lubricant composition of the present invention satisfies the requirements for SAE J300 viscosity grade 0Wx or 5Wx where x is 10, 20, 30 or 40.

5 In a non-limiting embodiment of the invention, the lubricant composition comprises a detergent inhibitor package. The detergent inhibitor package comprises one or more of the following: metal or ash-containing detergents, antioxidants, anti-wear agents, rust inhibitors, anti-foaming agents, demulsifiers, pour point depressants, etc.

10 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 a long hydrophobic tail, with the polar head comprising a metal salt of an acidic organic compound. The salts may contain a substantially stoichiometric
15 amount of the metal in which case they are usually described as normal or neutral salts, and would typically have a total base number or TBN (as may be measured by ASTM D2896) of from 0 to 80. It is possible to include large amounts of a metal base by reacting an excess of a metal compound such as an oxide or hydroxide with an
20 acidified detergent as the outer layer of a metal base (e.g. carbonate) micelle. Such overbased detergents may have a TBN of 150 or greater, and typically of from 250 to 450 or more.

Detergents that can be used include oil-soluble neutral and overbased sulfonates, phenates, sulfurized phenates, thiophosphonates, salicylates, and
25 naphthenates and other oil-soluble carboxylates of a metal, particularly the alkali or alkaline earth metals, e.g., sodium, potassium, lithium, calcium, and magnesium (With the constraints noted herein). The most commonly used metals are calcium and magnesium, which may both be present in detergents used in a lubricant, and mixtures of calcium and/or magnesium with sodium. Common metal detergents include
30 overbased calcium sulfonates having a TBN greater than or equal to 250, for example, a TBN from 250 to 450; neutral and overbased calcium phenates having a TBN

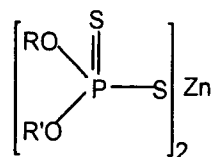
greater than or equal to 50; and sulfurized phenates having a TBN greater than or equal to 50.

Sulfonates can be prepared from sulfonic acids which are typically obtained by the sulfonation of alkyl substituted aromatic hydrocarbons such as those obtained
5 from the fractionation of petroleum or by the alkylation of aromatic hydrocarbons. Examples include those obtained by alkylating benzene, toluene, xylene, naphthalene, diphenyl or their halogen derivatives such as chlorobenzene, chlorotoluene and chloronaphthalene. The alkylation can be carried out in the presence of a catalyst with alkylating agents having from 3 to more than 70 carbon atoms. The alkaryl sulfonates
10 usually contain from 9 to 80 or more carbon atoms per alkyl substituted aromatic moiety.

The oil soluble sulfonates or alkyl aryl sulfonic acids can be neutralized with oxides, hydroxides, alkoxides, carbonates, carboxylate, sulfides, hydrosulfides, nitrates, borates and ethers of the metal. The amount of metal compound is chosen
15 having regard to the desired TBN of the final product but typically ranges from 100 to 220 wt. percent of the stoichiometrically required.

Dihydrocarbyl dithiophosphate metal salts are frequently used as anti-wear and antioxidant agents. The metal can be an alkali or alkaline earth metal, or aluminum, lead, tin, molybdenum, manganese, nickel or copper. The zinc salts are
20 typically used in lubricating oil in amounts of 0.1 to 10 wt. percent, for example, from 0.2 to 2 wt. percent, based upon the total weight of the lubricating oil composition. They can be prepared in accordance with known techniques by first forming a dihydrocarbyl dithiophosphoric acid (DDPA), usually by reaction of one or more alcohol or a phenol with P_2S_5 and then neutralizing the formed DDPA with a zinc
25 compound. For example, a dithiophosphoric acid can be made by reacting mixtures of primary and secondary alcohols. Alternatively, multiple dithiophosphoric acids can be prepared where the hydrocarbyl groups on one are entirely secondary in character and the hydrocarbyl groups on the others are entirely primary in character. To make the zinc salt any basic or neutral zinc compound could be used but the
30 oxides, hydroxides and carbonates are most generally employed. Commercial additives frequently contain an excess of zinc due to use of an excess of the basic zinc compound in the neutralization reaction.

Zinc dihydrocarbyl dithiophosphates are oil soluble salts of dihydrocarbyl dithiophosphoric acids and may be represented by the following formula:



wherein R and R' may be the same or different hydrocarbyl radicals containing from 1 to 18, for example, from 2 to 12, carbon atoms and including radicals such as alkyl, alkenyl, aryl, arylalkyl, alkaryl and cycloaliphatic radicals. In a non-limiting embodiment, R and R' groups are alkyl groups of 2 to 8 carbon atoms. Thus, the radicals can, for example, be ethyl, n-propyl, i-propyl, n-butyl, i-butyl, sec-butyl, amyl, n-hexyl, i-hexyl, n-octyl, decyl, dodecyl, octadecyl, 2-ethylhexyl, phenyl, butylphenyl, cyclohexyl, methylcyclopentyl, propenyl, butenyl. In order to obtain oil solubility, the total number of carbon atoms (i.e. R and R') in the dithiophosphoric acid will generally be 5 or greater. The zinc dihydrocarbyl dithiophosphate can therefore comprise zinc dialkyl dithiophosphates. Conveniently at least 50 (mole) percent of the alcohols used to introduce hydrocarbyl groups into the dithiophosphoric acids are secondary alcohols.

Greater percentages of secondary alcohols can be used. In some instances, high nitrogen systems may be required. Thus, the alcohols used to introduce the hydrocarbyl groups can be more than 60 mole percent secondary or more than 90 mole percent secondary. Metal dithiophosphates that are secondary in character give better wear control in tests such as the Sequence VE (ASTM D5302) and the GM 6.2L tests. The high levels of nitrogenous TBN required by the present invention to control soot related viscosity may increase wear and corrosion performance.

Oxidation inhibitors or antioxidants reduce the tendency of mineral oils to deteriorate in service which deterioration can be evidence by the products of oxidation such as sludge and varnish-like deposits on the metal surfaces and by viscosity growth. Such oxidation inhibitors include hindered phenols, oil soluble phenates and sulfurized phenates, phosphosulfurized or sulfurized hydrocarbons, phosphorous esters, metal thiocarbamates, oil soluble copper compounds as described in U.S. Pat. No. 4,867,890, and molybdenum containing compounds. Such compounds are utilized within the constraints noted herein.

In one aspect of the invention the lubricant includes at least 0.0008 mole percent hindered phenol antioxidant. Generally, hindered phenols are oil soluble phenols substituted at one or both ortho positions. Suitable compounds include monohydric and mononuclear phenols such as 2,6-di-tertiary alkylphenols (e.g. 2,6 di-
5 t-butylphenol, 2,4,6 tri-t-butyl phenol, 2-t-butyl phenol, 4-alkyl, 2,6, t-butyl phenol, 2,6 di-isopropylphenol, and 2,6 dimethyl, 4 t-butyl phenol). Other suitable hindered phenols include polyhydric and polynuclear phenols such as alkylene bridged hindered phenols (4,4 methylenebis(6 tert butyl-o-cresol), 4,4'-methylenebis(2-tert-amyl-o-cresol), and 2,2'-methylenebis (2,6-di-t-butylphenol). The hindered phenol
10 can be borated or sulfurized.

Rust inhibitors selected from the group consisting of nonionic polyoxyalkylene polyols and esters thereof, polyoxyalkylene phenols, and anionic alkyl sulfonic acids can be used.

Copper and lead bearing corrosion inhibitors can be used. Typically such
15 compounds are thiadiazole polysulfides containing from 5 to 50 carbon atoms, their derivatives and polymers thereof. Derivatives of 1, 3, 4 thiadiazoles such as those described in U.S. Pat. Nos. 2,719,125; 2,719,126; and 3,087,932; are typical. Other similar materials are described in U.S. Pat. Nos. 3,821,236; 3,904,537; 4,097,387; 4,107,059; 4,136,043; 4,188,299; and 4,193,882. Other additives are the thio and
20 polythio sulfenamides of thiadiazoles such as those described in UK. Patent Specification No. 1,560,830. Benzotriazoles derivatives also fall within this class of additives. When these compounds are included in the lubricating composition, they are typically present in an amount not exceeding 0.2 wt. percent active ingredient.

A small amount of a demulsifying component can be used. A suitable
25 demulsifying component is described in EP 330,522. It is obtained by reacting an alkylene oxide with an adduct obtained by reacting a bis-epoxide with a polyhydric alcohol. A treat rate of 0.001 to 0.05 mass percent active ingredient is typical.

Pour point depressants, otherwise known as lube oil flow improvers, lower the minimum temperature at which the fluid will flow or can be poured. Such additives
30 are well known. Typical of those additives which improve the low temperature fluidity of the fluid are C₈ to C₁₈ dialkyl fumarate/vinyl acetate copolymers and polyalkylmethacrylates. Likewise, dialkyl fumarate and vinyl acetate can be used as compatibilizing agents.

Incompatibility can occur when certain types of polymers for use in the manufacture of motor oil viscosity modifiers are dissolved in basestock. An uneven molecular dispersion of polymer which gives the mixture either a tendency to separate or a grainy appearance ensues. The problem is solved by using a compatibility agent
5 having a hydrocarbon group attached to a functional group that serves to break up or prevent packing.

Foam control can be provided by many compounds including an antifoamant of the polysiloxane type, for example, silicone oil or polydimethyl siloxane.

Some of the above-mentioned additives can provide a multiplicity of effects;
10 thus for example, a single additive can act as a dispersant-oxidation inhibitor. This approach is well known and does not require further elaboration. It is important to note that addition of the other components noted above must comply with the limitations set forth herein.

In a non-limiting embodiment, the invention comprises one or more ashless
15 dispersants. The ashless dispersants can include the polyalkenyl or borated polyalkenyl succinimide where the alkenyl group is derived from a C_3 - C_4 olefin, especially polyisobutenyl having a number average molecular weight of about 700 to 5,000. Other well known dispersants include the oil soluble polyol esters of hydrocarbon substituted succinic anhydride, e.g. polyisobutenyl succinic anhydride,
20 and the oil soluble oxazoline and lactone oxazoline dispersants derived from hydrocarbon substituted succinic anhydride and di-substituted amino alcohols.

In a non-limiting embodiment, lubricant composition contains 0.5 to 5 wt. percent of ashless dispersant.

In a non-limiting embodiment, the present invention comprises ashless
25 detergent. These ashless detergents and dispersants are so called despite the fact that, depending on their constitution, they may upon combustion yield a non-volatile material such as boric oxide or phosphorus pentoxide; however, they do not ordinarily contain metal and therefore do not yield a metal-containing ash on combustion. Many types are known in the art, and are suitable for use in lubricating compositions. These
30 include the following:

(1) Reaction products of carboxylic acids (or derivatives thereof) containing at least 34 with nitrogen containing compounds such as amines, organic hydroxy compounds such as phenols and alcohols, and/or basic inorganic materials. Examples

of these are described in the following patents: U.S. Pat. Nos. 3,219,666; 4,234,435; 4,904,401; and 6,165,235 which are hereby incorporated by reference.

(2) Reaction products of relatively high molecular weight aliphatic or alicyclic halides with amines such as oxyalkylene polyamines. Examples of these are
5 described for in the following patents which are hereby incorporated by reference: U.S. Pat. Nos. 3,275,554; 3,438,757; 3,454,555; and 3,565,804.

(3) Reaction products of alkyl phenols in which the alkyl group contains at least 30 carbon atoms with aldehydes and amines which may be characterized as "Mannich dispersants." Examples of these are described in the following patents
10 which are hereby incorporated by reference: U.S. Pat. Nos. 3,649,229; 3,697,574; 3,725,277; 3,725,480; 3,726,882; and 3,980,569.

(4) Products obtained by post-treating the amine or Mannich dispersants with such reagents as urea, thiourea, carbon disulfide, aldehydes, ketones, carboxylic acids, hydrocarbon-substituted succinic anhydrides, nitriles, epoxides, boron compounds,
15 phosphorus compounds or the like. Examples of these are described in the following patents which are hereby incorporated by reference: U.S. Pat. Nos. 3,639,242; 3,649,229; 3,649,659; 3,658,836; 3,697,574; 3,702,757; 3,703,536; 3,704,308; and 3,708,422.

(5) Interpolymers of oil-solubilizing monomers such as decyl methacrylate, vinyl decyl ether and high molecular weight olefins with monomers containing polar
20 substituents, e.g., aminoalkyl acrylates or acrylamides and poly-(oxyethylene)-substituted acrylates. Examples of these are described in the following patents which are hereby incorporated by reference: U.S. Pat. Nos. 3,329,658; 3,449,250; 3,519,565; 3,666,730; 3,687,849; and 3,702,300.

25 The detergent inhibitor package of the present invention can contain phosphorus, sulfur, chlorine, ash, etc. In a non-limiting embodiment of the invention, the lubricant composition comprises less than 0.08 weight percent of phosphorus. In another non-limiting embodiment of the invention, the lubricant composition comprises less than 0.5 weight percent of sulfur. In yet another non-limiting
30 embodiment of the invention, the lubricant composition comprises less than 150 PPM, for example, less than 50 PPM of chlorine. And, in another non-limiting embodiment of the invention, the lubricant composition comprises 0.35 to 2 mass percent of ash.

Examples

The following non-limiting examples, Examples 1-12, illustrate the present invention. Various concentrates made by blending a first polymer concentrate and a commercially available SN 100 Group I base stock at a temperature between 60°C and 70°C for 45 minutes were used to formulate the different examples. Different first polymer concentrates, Polymer Concentrates 1-3, were used to formulate the different examples. Polymer Concentrate 1 is commercially available from Infineum USA as SV145; Polymer Concentrate 2 is commercially available from Infineum USA as SV265; and Polymer Concentrate 3 is commercially available from Chevron Corporation as Paratone 8451. The kinematic viscosity ratios and the shear stability indices (SSI) of the first polymer concentrates used in the examples are shown in Table 12.

Several different grades of lubricant compositions were prepared by blending various base stocks with the concentrates described above according to well known methods and techniques. The viscometric properties of the different basestocks, Basestock 1-7, used to make the examples are described in Table 11.

In the various examples, Component 1 is a detergent inhibitor package commercially available from Infineum USA as P5224; Component 2 is a pour point depressant commercially available from Infineum USA as V385; and Component 3 is a detergent inhibitor package commercially available from Infineum USA as P6000.

Examples 1-3 are representative of 5W20 lubricant compositions. Compositional information for Examples 1-3 is shown in Table 3. Examples 4-6 are representative of 5W30 lubricant compositions. Compositional information for Examples 1-3 is shown in Table 5. Examples 7-9 are representative of 0W30 PAO lubricant compositions. Compositional information for Examples 7-9 is shown in Table 7. Examples 10-12 are representative of 0W20 PAO lubricant compositions. Compositional information for Examples 10-19 is shown in Table 9.

The kinematic viscosity of the exemplary compositions was measured at 100°C and 150°C was measured according to ASTM D445. The HTHS of the lubricant compositions were made according to ASTM D4741. Results for the various examples are shown in Tables 4, 6, 8 and 10.

Table 3. Compositional Information for Exemplary 5W20 Lubricants

Component	Ex. 1 [wt%]	Ex. 2 [wt%]	Ex. 3 [wt%]
Component 1	9.60	9.60	9.60
Basestock 1	38.36	39.31	39.95
Basestock 2	46.90	47.90	46.63
Polymer Concentrate 1	4.93	0.00	0.00
Polymer Concentrate 2	0.00	2.99	0.00
Polymer Concentrate 3	0.00	0.00	3.61
Component 2	0.20	0.20	0.20

Table 4. Performance Information for Exemplary 5W20 Lubricants

	Ex. 1	Ex. 2	Ex. 3
Kv100 [cSt]	8.56	8.66	8.73
CCS at -30°C [cp]	5570	5620	5440
HTHS at 150°C [cp]	2.61	2.71	2.77

5 Conclusion

Examples 1-3 are illustrative of 5W20 lubricant compositions with Example 1 being illustrative of the present invention. As expected, Example 1 has the lowest HTHS of the exemplary 5W20 lubricant compositions.

10

Table 5. Compositional Information for Exemplary 5W30 Ultra Lubricants

Component	Ex. 4 [wt%]	Ex. 5 [wt%]	Ex. 6 [wt%]
Component 1	9.60	9.60	9.60
Basestock 1	30.85	32.68	32.12
Basestock 2	50.35	52.00	51.64
Polymer Concentrate 1	9.00	0.00	0.00
Polymer Concentrate 2	0.00	5.52	0.00
Polymer Concentrate 3	0.00	0.00	6.44
Component 2	0.20	0.20	0.20

Table 6. Performance Information for Exemplary 5W30 Ultra Lubricants

	Ex. 4	Ex. 5	Ex. 6
kv100 [cSt]	10.82	10.81	10.86
CCS at -30°C [cp]	6250	6510	6470
HTHS at 150°C [cp]	2.93	3.12	3.22

Conclusion

5 Examples 4-6 are illustrative of 5W30 lubricant compositions with Example 4 being illustrative of the present invention. As expected, Example 4 has the lowest HTHS of the exemplary 5W30 lubricant compositions.

Table 7. Compositional Information for Exemplary 0W30 PAO Lubricants

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Component	Ex. 7 [wt%]	Ex. 8 [wt%]	Ex. 9 [wt%]
Component 3	12.00	12.00	12.00
Polymer Concentrate 1	9.71	0.00	0.00
Polymer Concentrate 2	0.00	6.09	0.00
Polymer Concentrate 3	0.00	0.00	6.91
Basestock 7	2.00	2.00	2.00
Basestock 5	45.05	48.26	47.55
Basestock 6	31.04	31.45	31.34
Component 2	0.20	0.20	0.20

Table 8. Performance Information for Exemplary 0W30 PAO Lubricants

	Ex. 7	Ex. 8	Ex. 9
kv100 [cSt]	10.69	10.82	10.82
CCS at -35°C [cp]	5930	5870	5670
HTHS at 150°C [cp]	2.93	3.14	3.28

Conclusion

Examples 7-9 are illustrative of 0W30 PAO lubricant compositions with Example 7 being illustrative of the present invention. As expected, Example 7 has the lowest HTHS of the exemplary 5W30 PAO lubricant compositions.

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Table 9. Compositional Information for Exemplary 0W20 PAO Lubricants

Component	Ex. 10 [wt%]	Ex. 11 [wt%]	Ex. 12 [wt%]
Component 3	12.00	12.00	12.00
Polymer Concentrate 1	5.30	0.00	0.00
Polymer Concentrate 2	0.00	3.23	0.00
Polymer Concentrate 3	0.00	0.00	3.68
Basestock 7	2.00	2.00	2.00
Basestock 4	46.85	48.92	48.47
Basestock 5	33.65	33.65	33.65
Component 2	0.20	0.20	0.20

Table 10. Performance Information for Exemplary 0W20 PAO Lubricants

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	Ex. 10	Ex. 11	Ex. 12
kv100 [cSt]	8.83	8.91	8.93
CCS at -35°C [cp]	5720	5620	5540
HTHS at 150°C [cp]	2.70	2.80	2.87

Conclusion

Examples 10-12 are illustrative of 0W20 PAO lubricant compositions with Example 10 being illustrative of the present invention. As expected, Example 10 has the lowest HTHS of the exemplary 5W20 PAO lubricant compositions.

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Table 11. Viscosities of the Basestocks

Basestock	kv at 40°C	kv at 100°C	VI
Basestock 1	19.70	4.26	125
Basestock 2	44.49	7.36	130
Basestock 3	19.64	4.03	103
Basestock 4	54.95	7.69	104
Basestock 5	17.61	3.98	126
Basestock 6	47.44	7.95	139
Basestock 7	18.79	4.26	138

Table 12. Description of Polymer Concentrates 1-3

	Kinematic Viscosity Ratio	Shear Stability Index [%]
Polymer Concentrate 1	0.15	52.8
Polymer Concentrate 2	0.41	7.0
Polymer Concentrate 3	0.39	49.7

- 5 The shear stability indices of the Polymer Concentrates in Table 12 were determined according to ASTM D6278 using polymer solutions prepared by blending Polymer Concentrates 1, 2 and 3, respectively, and a Group I basestock having a kv100 of 4.70 cSt. The kv100 of the solution was 15.0 ± 0.2 cSt.

CLAIMS:

1. An SAE J300 viscosity grade lubricant composition comprising:
 - a first polymer having a kinematic viscosity ratio less than or equal to 0.25 and a shear stability index (SSI) equal to or greater than 20 percent which is present in the composition in an amount less than 10 weight % based on the weight of the lubricant composition; and
 - base oil having a viscosity index equal to or greater than 120,wherein (1) the viscosity grade of the lubricant composition is 0Wx or 5Wx where x is 10, 20, 30 or 40 and (2) the lubricant composition exhibits an HTHS within 3.85% of the minimum HTHS for the specific viscosity grade.
2. A lubricant composition according to claim 1 where the first polymer comprises a minimum of 5 weight percent styrene.
3. A lubricant composition according to claim 1 where the first polymer comprises a normal block copolymer or a random block copolymer.
4. A 0W20 viscosity grade lubricant composition comprising:
 - a first polymer having a kinematic viscosity ratio less than or equal to 0.25 and a shear stability index (SSI) equal to or greater than 20 percent which is present in the composition in an amount less than 5 weight % based on the weight of the lubricant composition; and
 - base oil having a viscosity index equal to or greater than 120, wherein the lubricant composition exhibits an HTHS within 3.85% of the minimum HTHS for the specific viscosity grade which is 2.6.
5. A lubricant composition according to claim 4 further comprising a second polymer selected from a group consisting of olefin polymers; hydrogenated polymers and copolymers and terpolymers of styrene with isoprene and/or butadiene; polymers of alkyl acrylates or alkyl methacrylates; copolymers of alkyl methacrylates with N-vinyl pyrrolidone or dimethylaminoalkyl methacrylate; post-grafted polymers of ethylenepropylene with an active

monomer such as maleic anhydride; styrene-maleic anhydride polymers post-reacted with alcohols and amines

6. A lubricant composition according to claim 4 further comprising a detergent inhibitor package.

7. A lubricant composition according to claim 6 wherein the detergent inhibitor package is present in an amount ranging from 9.6 to 12.0 weight percent of the lubricant composition.

8. A lubricant composition according to claim 6 further comprising a pour point depressant.

9. A 0W30 viscosity grade lubricant composition comprising: a polymer having a kinematic viscosity ratio less than or equal to 0.25 and a shear stability index (SSI) equal to or greater than 20 percent which is present in the composition in an amount less than 10 weight % based on the weight of the lubricant composition; and

a base oil having a viscosity index equal to or greater than 120,
wherein the concentration of phosphorus in the lubricant composition is less than 0.08 weight percent and the concentration of sulfur is less than 0.5 weight percent,

wherein the lubricant composition exhibits an HTHS within 3.85% of the minimum HTHS for the specific viscosity grade which is 2.9.

10. A lubricant composition according to claim 9 wherein the base oil comprises a Group III base stock and/or a Group IV base stock.