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(54) **Low sulfur, low ash, low phosphorus and low base number lubricating oil composition using an alkylamine salt of a dialkylmonothiophosphate**

Schmierstoffzusammensetzung mit niedrigem Schwefel-, Phosphor-, Aschegehalt und niedriger Basenzahl enthaltend ein Alkylaminsalz eines Dialkylmonothiophosphats

Composition lubrifiante à faible teneur en soufre, en phosphore, en cendres et en bases contenant un alkylammonium dialkylmonothiophosphate

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Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to lubricating oil compositions, their method of preparation, and use. More specifically, this invention relates to an engine crankcase lubricating oil with low sulfur, low ash, and low phosphorus levels.

BACKGROUND OF THE INVENTION

[0002] Combustion engines generate emissions that can pollute our environment. In response to increasing regulation and environmental concerns, engine manufacturers have recognized the need to reduce engine emissions. In an effort to reduce emissions in exhaust gases, manufacturers have used particulate traps and catalytic converters. However, the lubricating oil used in the engine is oftentimes detrimental to devices such as catalytic converters or particulate traps. For example, phosphorus present in the lubricating oil is believed to interfere with catalytic efficiency. Further, it is believed that sulfur present in the lubricating oil, after oxidation and neutralization, may form sulfates that plug exhaust gas traps thereby preventing them from oxidizing and burning off trapped organic particulate matter. Accordingly, engine manufacturers are requiring lubricating oils that have lower and lower sulfur, ash, and phosphorus levels.

SUMMARY OF THE INVENTION

[0003] An object of the present invention is to provide lubricating oils for lubricating an engine crankcase, that contain minimal sulfur, ash, and phosphorus levels. This can be achieved using an oil soluble lubricating additive package to formulate a low sulfur, low ash, and low phosphorus content oil for lubricating an engine crankcase in either gasoline or diesel engines.

[0004] Additionally, another goal of the present invention is to provide a method for lubricating the moving parts of a machine.

[0005] The present invention provides a lubricating oil suitable for lubricating an engine crankcase, comprising an oil soluble lubricant additive package, which additive package comprises:

(a) an alkylamine salt of a dialkylmonothiophosphate, and
(b) at least one component selected from detergents, dispersants, antioxidants, friction modifiers, viscosity index improvers, and pour point depressants,

wherein said lubricating oil has a total base number of less than 10, and (a) a sulfur content less than 0.3 wt%, (b) a phosphorus content of less than 0.11 wt%, and (c) an ash content less than 1.2 wt%.

[0006] The lubricating oil of the present invention is suitable for lubricating an engine crankcase. It can be used to lubricate any machine for which the inventive lubricating oil would provide satisfactory lubrication. It is envisioned that such machinery may include gas engines, diesel engines, turbine engines, automatic transmissions, manual transmissions, hypoid axles, and gear boxes.

[0007] The present invention also includes a method for lubricating an engine crankcase comprising the step of; at least partially filling the crankcase with a lubricating oil of the invention as described above.

[0008] Further, the present invention provides a method for lubricating moving parts of a machine, said method comprising the step of: contacting at least one moving part with a lubricant oil of the present invention as described above. The method may be successfully employed on a wide variety of machines. It is envisioned that such machinery may Include: gas engines, diesel engines, turbine engines, automatic transmissions, manual transmissions, hypoid axles, and gear boxes.

[0009] Preferably, the additive package for use according to the present Invention comprises at least one alkylamine salt of a dialkylmonothiophosphate; and (i) at least one detergent, wherein the weight ratio of said alkylamine salt of a dialkylmonothiophosphate to said detergent is from 0.05:1 to 3:1, or (ii) at least one dispersant, wherein the weight ratio of said alkylamine salt of a dialkylmonothiophosphate to said dispersant is from 1:4 to 1:20, or (iii) at least one antioxidant, wherein the weight ratio of said alkylamine salt of a dialkylmonothiophosphate to antioxidant is from 10:1 to 1:5. In an embodiment at least one of the at least one detergent is selected from the group consisting of calcium sulfonate, magnesium sulfonate, sodium sulfonate, non-sulfurized Mannich phenates, sulfurized phenates, salicylates, overbased salicylates, saligenin, overbased saligenin, overbased carboxylic acids, and combinations thereof. Preferably the additive package comprises at least one detergent selected from calcium suflonate, magnesium sulfonate, sodium sulfonate, non-sulfurized Mannich phenates, sulfurized phenates, salicylates, overbased saligenin, and combinations thereof.

[0010] It is also useful herein if at least one dispersant used in the oil soluble lubricant additive package described above has a molecular weight of from about 1,000 to about 20,000 amu. In one embodiment the at least one dispersant

is a maleic anhydride functionalized polyisobutylene polymer that has been reacted with a polyamine. Also the at least one dispersant can be a product of a Mannich reaction. It is further equally possible that the at least one dispersant is an ethylene-propylene type dispersant.

[0011] It is further preferred in one embodiment that the oil soluble lubricant additive package described above additionally comprise at least one component selected from the group consisting of: viscosity index improvers and pour point depressants.

[0012] In one embodiment the ash content of the lubricating oil is less than 1.0 wt% and in another embodiment is less than 0.8 wt%.

[0013] It is preferred that at least one antioxidant used in the oil soluble lubricant additive package of the present invention is selected from the group consisting of: alkylated diphenylamines, sulfurized olefins, phenols, hindered phenols, and sulfurized phenols.

[0014] It is preferred that the oil soluble lubricant additive package for use according to the present invention as described above has at least one property selected from the group consisting of: a sulfur content less than about 3 wt% and a phosphorus content less than about 1.2 wt%.

[0015] It is preferred that the oil soluble lubricant additive package is essentially free of non-sulfurized Mannich phenate.

[0016] The lubricating oil of the present invention should have a total base number of less than 10 mg KOH/g.

[0017] The present invention also provides a method of achieving a low sulfur, low ash, and low phosphate oil formulation, said method comprising providing an oil soluble lubricant additive package for use according to the present invention as defined above, and (2) admixing said oil soluble lubricant additive package with at least a base oil so as to form a lubricating oil suitable for lubricating an engine crankcase and having a total base number of less than 10, a sulfur content less than 0.3 wt%, a phosphorus content of less than 0.11 wt%, and an ash content less than 1.2 wt%. In one embodiment the ash content of the lubricating oil is less than about 1.0 wt% and in another embodiment is less than about 0.8 wt%.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0018] In accordance with the foregoing summary, the following presents a detailed description of the preferred embodiment of the invention that is currently considered to be the best mode.

[0019] We begin with a discussion of the various components employed in the present invention. Then we shall present an example of an oil formulation based upon the oil soluble additive package of the present invention. Finally, we conclude with a comparison of an inventive oil formulation against a control formulation in the CAT 1N engine test.

BASE OIL

[0020] The base oils useful herein include natural lubricating oils, synthetic lubricating oils and mixtures thereof. Suitable lubricating oils also include basestocks obtained by isomerization of synthetic wax and slack wax, as well as basestocks produced by hydrocracking the aromatic and polar components of the crude. In general, both the natural and synthetic lubricating oils will each have a kinematic viscosity ranging from about 1 to about 40 mm^2/s (cSt) at 100° C, although typical applications will require each of the base oils to have a viscosity ranging from about 1 to about 12, preferably 2 to 8, mm^2/s (cSt) at 100° C.

[0021] Natural lubricating oils include animal oils, vegetable oils (e.g., castor oil and lard oil), petroleum oils, mineral oils, and oils derived from coal or shale. The preferred natural lubricating oil is mineral oil.

[0022] The mineral oils useful in this invention can include but are not limited to all common mineral oil base stocks. This would include oils that are naphthenic or paraffinic in chemical structure. Oils that are refined by conventional methodology using acid, alkali, and clay or other agents such as aluminum chloride, or be extracted oils produced, for example, by solvent extraction with solvents such as phenol, sulfur dioxide, furfural, dichlorodiethyl ether, etc. They may be hydrotreated or hydrorefined, dewaxed by chilling or catalytic dewaxing processes, or hydrocracked. The mineral oil may be produced from natural crude sources or be composed of isomerized wax materials or residues of other refining processes. In one embodiment, the oil of lubricating viscosity is a hydrotreated, hydrocracked and/or iso-dewaxed mineral oil having a Viscosity Index (VI) of greater than 80, preferably greater than 90; greater than 90 volume % saturates and less than 0.03 wt. % sulfur.

[0023] Group II and Group III basestocks are also particularly suitable for use in the present invention, and are typically prepared from conventional feedstocks using a severe hydrogenation step to reduce the aromatic, sulfur and nitrogen content, followed by dewaxing, hydrofinishing, extraction and/or distillation steps to produce the finished base oil. Group II and III basestocks differ from conventional solvent refined Group I basestocks in that their sulfur, nitrogen and aromatic contents are very low. As a result, these base oils are compositionally very different from conventional solvent refined basestocks. The American Petroleum Institute has categorized these different basestock types as follows: Group I, >0.03 wt. % sulfur, and/or <90 vol% saturates, viscosity index between 80 and 120; Group II, ≤ 0.03 wt. % sulfur, and ≥ 90

vol% saturates, viscosity index between 80 and 120; Group III, ≤ 0.03 wt. % sulfur, and ≥ 90 vol% saturates, viscosity index > 120; Group IV, poly-alpha-olefins. Hydrotreated basestocks and catalytically dewaxed basestocks, because of their low sulfur and aromatics content, generally fall into the Group II and Group III categories.

[0024] There is no limitation as to the chemical composition of the various basestocks used in the present invention. For example, the proportions of aromatics, paraffinics, and naphthenics in the various Group I, Group II and Group III oils can vary substantially. The degree of refining and the source of the crude used to produce the oil generally determine this composition. In one embodiment, the base oil comprises a mineral oil having a VI of at least 110.

[0025] The lubricating oils may be derived from refined, re-refined oils, or mixtures thereof. Unrefined oils are obtained directly from a natural source or synthetic source (e.g., coal, shale, or tar sands bitumen) without further purification or treatment. Examples of unrefined oils include shale oil obtained directly from a retorting operation, petroleum oil obtained directly from distillation, or an ester oil obtained directly from an esterification process, each of which is then used without further treatment. Refined oils are similar to the unrefined oils except that refined oils have been treated in one or more purification steps to improve one or more properties. Suitable purification techniques include distillation, hydrotreating, dewaxing, solvent extraction, acid or base extraction, filtration, and percolation, all of which are known to those skilled in the art. Re-refined oils are obtained by treating used oils in processes similar to those used to obtain the refined oils. These re-refined oils are also known as reclaimed or reprocessed oils and are often additionally processed by techniques for removal of spent additives and oil breakdown products.

[0026] Synthetic lubricating oils include hydrocarbon oils and halo-substituted hydrocarbon oils such as oligomerized, polymerized, and interpolymerized olefins; alkylbenzenes;. polyphenyls; and alkylated diphenyl ethers, alkylated diphenyl sulfides, as well as their derivatives, analogs, and homologs thereof, and the like. Preferred synthetic oils are oligomers of α-olefins, particularly oligomers of 1-decene, having a viscosity ranging from about 1 to about 12, preferably 2 to 8, mm^2/s (cSt) at 100° C. These oligomers are known as poly-α-olefins or PAOs.

[0027] Synthetic lubricating oils also include alkylene oxide polymers, interpolymers, copolymers, and derivatives thereof where the terminal hydroxyl groups have been modified by esterification, etherification, etc. This class of synthetic oils is exemplified by polyoxyalkylene polymers prepared by polymerization of ethylene oxide or propylene oxide; the alkyl and aryl ethers of these polyoxyalkylene polymers (e.g., methyl-polyisopropylene glycol ether having an average molecular weight of 1000, diphenyl ether of polypropylene glycol having a molecular weight of 100-1500); and mono- and poly-carboxylic esters thereof (e.g., the acetic acid esters, mixed C_3-C_8 fatty acid esters, and C_{12} oxo acid diester of tetraethylene glycol).

[0028] Another suitable class of synthetic lubricating oils comprises the esters of dicarboxylic acids (e.g., phthalic acid, succinic acid, alkyl succinic acids and alkenyl succinic acids, maleic acid, azelaic acid, subric acid, sebasic acid, fumaric acid, adipic acid, linoleic acid dimer, malonic acid, alkylmalonic acids, alkenyl malonic acids, etc.) with a variety of alcohols (e.g., butyl alcohol, hexyl alcohol, dodecyl alcohol, 2-ethylhexyl alcohol, ethylene glycol, diethylene glycol monoethers, propylene glycol, etc.). Specific examples of these esters include dibutyl adipate, di(2-ethylhexyl) sebacate, di-n-hexyl fumarate, dioctyl sebacate, diisooctyl azelate, diisodecyl azelate, dioctyl isothalate, didecyl phthalate, dieicosyl sebacate, the 2-ethylhexyl diester of linoleic acid dimer, and the complex ester formed by reacting one mole of sebasic acid with two moles of tetraethylene glycol and two moles of 2-ethyl-hexanoic acid, and the like. A preferred type of oil from this class of synthetic oils is adipates of C_4 to C_{12} alcohols.

[0029] Esters useful as synthetic lubricating oils also include those made from C_5 to C_{12} monocarboxylic acids and polyols and polyol ethers such as neopentyl glycol, trimethylolpropane pentaeythritol, dipentaerythritol, tripentaerythritol, and the like.

[0030] Silicon-based oils (such as the polyalkyl-, polyaryl-, polyalkoxy-, or polyaryloxy-siloxane oils and silicate oils) comprise another useful class of synthetic lubricating oils. These oils include tetra-ethyl silicate, tetra-isopropyl silicate, tetra-(2-ethylhexyl) silicate, tetra-(4-methyl-2-ethylhexyl) silicate, tetra-(p-tert-butylphenyl) silicate, hexa-(4-methyl-2-pentoxy)-disiloxane, poly(methyl)-siloxanes and poly (methylphenyl) siloxanes, and the like. Other synthetic lubricating oils include liquid esters of phosphorus containing acids (e.g., tricresyl phosphate, trioctylphosphate, and diethyl ester of decylphosphonic acid), polymeric tetra-hydrofurans, poly-alpha-olefins, and the like.

VISCOSITY INDEX IMPROVERS

[0031] Viscosity index improvers impart high and low temperature operability to the lubricating oil and permit it to remain relatively viscous at elevated temperatures and also exhibit acceptable viscosity or fluidity at low temperatures. Viscosity index improvers are generally high molecular weight hydrocarbon polymers including polyesters. The viscosity index improvers may also be derivatized to include other properties or functions, such as the addition of dispersancy properties. These oil soluble viscosity modifying polymers will generally have number average molecular weights of from 10^3 to 10^6, preferably 10^4 to 10^6, as determined by gel permeation chromatography or osmometry.

[0032] The viscosity index improvers useful herein can include polymethacrylate-based ones, olefin copolymer-based ones, (e.g., isobutylene-based and ethylene-propylene copolymer based ones), polyalkyl styrene-based ones, hydro-

genated styrene-butadiene copolymer-based ones, and styrene-maleic anhydride ester copolymer-based ones.

[0033] Representative examples of suitable viscosity index improvers are found in U.S. Pat. Nos. 5,075,383; 5,102,566; 5,139,688; 5,238,588; and 6,107,257.

POUR POINT DEPRESSANTS

[0034] Pour point depressants are used to improve low temperature properties of oilbased compositions. See, for example, page 8 of "Lubricant Additives" by C.V. Smalheer and R. Kennedy Smith (Lezius Hiles Co. publishers, Cleveland, Ohio, 1967). Examples of useful pour point depressants are polymethacrylates; polyacrylates; polyacrylamides; condensation products of haloparaffin waxes and aromatic compounds; vinyl carboxylate polymers; and ter-polymers of dialkylfumarates, vinyl esters of fatty acids and alkyl vinyl ethers. Pour point depressants are described in U.S. Patent Nos. 2,387,501; 2,015,748; 2,655,479; 1,815,022; 2,191,498; 2,666,746; 2,721,877; 2,721,878; and 3,250,715.

DISPERSANTS

[0035] Dispersants used in the present invention may be ash-producing or ashless. Suitable dispersants for use herein can typically comprise amine, alcohol, amide, or ester polar moieties attached to the polymer backbone via a bridging group. The dispersant may be, for example, 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 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, and Koch reaction products. The long chain aliphatic hydrocarbons can be polymers such as polyalkylenes, including, for example, polyisobutylene, polyethylene, polypropylene, and copolymers thereof and/or copolymers with other alpha-olefins. Typical PIB molecular weights useful herein can range from about 950 to 6000.

[0036] Representative examples of dispersants suitable for use in the present invention are found in U.S. Patent Nos. 5,075,383; 5,139,688; 5,238,588; and 6,107,257. Additional representative examples are found in U.S. Patent Application Publication No. 2001/0036906A1.

DETERGENTS

[0037] A detergent is an additive that reduces the formation of piston deposits, for example high-temperature varnish and lacquer deposits, in engines. Detergents typically possess acid-neutralizing properties and are capable of keeping finely divided solids in suspension. Metal detergents are used preferably for improving the acid-neutralizing properties, high-temperature detergency, and anti-wear properties of the resulting lubricating oil composition.

[0038] Detergents used herein may be any detergent used in lubricating oil formulations, and may be of the ash-producing or ashless variety. Detergents suitable for use in the present invention include all of the detergents customarily used in lubricating oils, including metal detergents. Specific examples of metal detergents are those selected from alkali metal or alkaline earth metal sulfonates, alkali metal or alkaline earth metal phenates, and alkali metal or alkaline earth metal salicylates. In an embodiment, the lubricating oil formulation is essentially free of sulfurized phenate detergent.

[0039] Representative examples of suitable detergents useful in the present invention are found in U.S. Pat. Nos. 6,008,166. Additional representative examples of suitable detergents are found in U.S. Patent Application Nos. 2002/0142922A1, 2002/0004069A1, and 2002/0147115A1.

ALKYLAMINE SALT OF A DIALKYLMONOTHIOPHOSPHATE

[0040] Although any oil soluble alkylamine salt of a dialkylmonothiophosphate that imparts suitable anti-wear performance to the finished oil may be used in the present invention, a synthesis method for a preferred alkylamine salt of a dialkylmonothiophosphate for use in the present invention follows.

[0041] In a round bottom flask equipped with a thermocouple, stirrer, addition funnel and condenser is charged 148.50 grams of ARMEEN OL. An effective amount of di-n-butyl hydrogen phosphite (DBHP) is charged to the addition funnel. Begin vigorous stirring of the ARMEEN OL and charge an effective amount of elemental sulfur to the reactor. After the sulfur addition is complete, immediately begin adding the DBHP dropwise to the reactor. The reaction temperature should not exceed 70 °C. The temperature can be adjusted by the rate of DBHP addition. The DBHP is charged over four hours. The reaction should be monitored for DBHP buildup by taking an IR each hour and checking the IR for unreacted DBHP. After the DBHP addition is complete, charge the n-octylamine (13.29 grams). Heat the reaction for 30 minutes at 50 °C.

[0042] ARMEEN OL is a commercial product from AKZO Nobel. ARMEEN OL is a primary oleyl amine. Other amines supplied by AKZO Nobel suitable for this invention include ARMEEN 12D, ARMEEN 16D, ARMEEN 18D, ARMEEN O, ARMEEN OD, ARMEEN OLD, ARMEEN C, ARMEEN S, and ARMEEN SD. Any primary, secondary or tertiary amine

is suitable as long as the final product is oil soluble and it imparts suitable anti-wear performance to an oil.

[0043] The alykl groups on the phosphite and/or phosphate can be of any length as long as the final product is oil soluble and it imparts suitable anti-wear performance to an oil.

ANTIOXIDANTS

[0044] Useful antioxidant materials include oil soluble phenolic compounds, oil soluble sulfurized organic compounds, oil soluble amine antioxidants, oil soluble organo borates, oil soluble organo phosphites, oil soluble organo phosphates, oil soluble organo dithiophosphates and mixtures thereof. Such antioxidants can be metal free (that is, free of metals which are capable of generating sulfated ash), and therefore are most preferably ashless (having a sulfated ash value not greater than 1 wt. % SASH, as determined by ASTM D874).

[0045] Representative examples of suitable antioxidants useful in the present invention are found in U.S. Patent No. 5,102,566. Additional representative examples of suitable antioxidants useful in the present invention are found in U.S. Patent Application Publication No. 2001/0012821A1.

FRICTION MODIFIERS

[0046] Friction modifiers serve to impart the proper friction characteristics to lubricating oil compositions.

[0047] Friction modifiers include such compounds as aliphatic amines or ethoxylated aliphatic amines, aliphatic fatty acid amines, aliphatic carboxylic acids, aliphatic carboxylic esters of polyols such as glycerol esters of fatty acid as exemplified by glycerol phenate, aliphatic carboxylic ester-amides, aliphatic phosphonates, aliphatic phosphates, aliphatic thiophosphonates, aliphatic thiophosphates, etc., wherein the aliphatic group usually contains above about eight carbon atoms so as to render the compound suitably oil soluble. Also suitable are aliphatic substituted succinimides formed by reacting one or more aliphatic succinic acids or anhydrides with ammonia. Additionally suited for use in the present invention are friction modifiers containing molybdenum.

[0048] Representative examples of molybdenum-containing friction modifiers include those found in U.S. Patent Nos. 5,650,381; RE37,363E; 5,628,802; 4,889,647; 5,412,130; 4,786,423; 4,812,246; 5,137,647; 5,364,545; 5,840,672; 5,925,600; 5,962,377; 5,994,277; 6,017,858; 6,150,309; 6,174,842; 6,187,723; 6,268,316; European Patent Nos. EP 222 143 B1; EP 281 992 B1; EP 719 314 B1; EP 719 315 B1; EP 874 040 A1; EP 892 037 A1; EP 931 827 A1; EP 1 041 134 A1; EP 1 041 135 A1; EP 1 087 008 A1; EP 1 088 882 A1; EP; Japanese Patent No. JP 11035961; and International Publication Nos. WO 95/07965; WO 00/08120; WO 00/71649.

[0049] Representative examples of suitable friction modifiers are found in U.S. Pat. Nos. 3,933,659; 4,105,571; 3,779,928; 3,778,375; 3,852,205; 3,879,306; 3,932,290; 3,932,290; 4,028,258; 4,344,853; 5,102,566; 6,103,674; 6,174,842; 6,500,786; 6,500,786; and 6,509,303. Additional representative examples of suitable friction modifiers are found in U.S. Patent Application Publication No. 2002/0137636 A1.

CAT 1N ENGINE TEST RESULTS

[0050] The CAT 1N engine test is a commonly used test for evaluating the acceptability of heavy-duty diesel engine oils for Caterpillar engines. The test employs a single cylinder aluminum piston diesel engine. The acceptability of an oil formulation is based upon the following parameters: average oil consumption, piston deposits, % top groove fill, % top land heavy carbon. Further, in order to pass the CAT 1 N diesel test, no stuck pistons, piston rings or liner distress is permitted.

[0051] To determine the efficacy of the additive package for use according to the present invention, a control formulation comprising a zinc dialkyldithiophosphate was compared to a formulation wherein the zinc dialkyldithiophosphate was replaced by an alkylamine salt of a dialkylmonothiophosphate with a compensating reduction in the amount of base oil. Detergent #1 is a metal sulfonate and detergent #2 is a commercially available metal salicylate detergent. In this example, the weight ratio of alkylamine salt of a dialkylmonothiophosphate to combined detergents is 0.675 to 1.45 or about 1:2.14.

Composition, wt% basis	Control Formulation	Inventive Formulation
Base Oil #1	52.00	51.575
Base Oil #2	27.00	27.00
Viscosity Index Improver	8.50	8.50
Pour Point Depressant	0.20	0.20
Dispersant #1	3.00	3.00

(continued)

Composition, wt% basis	Control Formulation	Inventive Formulation
Dispersant #2	5.03	5.03
Detergent #1	0.50	0.50
Detergent #2	0.95	0.95
Alkylamine salt of a dialkylmonothiophosphate	0.00	0.675
Zinc Dialkyldithiophosphate	0.25	0.00
Antioxidant #1	0.50	0.50
Antioxidant #2	0.50	0.50
Anti-Foaming Agent	0.01	0.01
Friction Modifier	0.50	0.50
Process Oil	1.06	1.06
Kinematic Viscosity @ 100°C	13.79 centistoke	13.17 centistoke

[0052] The following table compares the control formulation's performance against the inventive formulation. The column marked "Test #1" provides the pass/fail limits for the CAT 1N test for a single trial. If a given oil formulation does not provide satisfactory results with a single trial, multiple trials may be averaged together and this average compared against the corresponding pass/fail limits for the number of tests being averaged. That is to say, if two trials of the inventive formulation were averaged together, the averaged results would be compared against the pass/fail limits provided in the "Test#2" column.

	Control Formulation	Inventive Formulation	Test #1	Test #2	Test #3
TLHC, %	0	0	3	4	5
TGF, %	9	9	20	23	25
WD	260.9	235.2	286.2	311.7	323
O.C., avg	0.205	0.201	0.5 max (0 - 252 hour)		
O.C.E.O.T.	0.21	0.212	No scuffing		
TLHC, % - Top Land Heavy Carbon TGF, % - Top Groove Fill WD - Weight of Deposit O.C. - Oil Consumption O.C.E.O.T. - Oil Consumption at End of Test					

[0053] As can be seen from the table above, the inventive formulation performed well in the CAT 1N test. The inventive formulation did not require additional trials, as single trial performance was satisfactory. The inventive formulation exhibited a marked reduction in weight of deposit. These results demonstrate the improved performance imparted to the formulated oil by the substitution of an alkylamine salt of a dialkylmonothiophosphate for zinc dialkyldithiophosphate.

Claims

1. A lubricating oil suitable for lubricating an engine crankcase, comprising an oil soluble lubricant additive package, which additive package comprises:

(a) an alkylamine salt of a dialkylmonothiophosphate; and
(b) at least one component selected from detergents, dispersants, antioxidants, friction modifiers, viscosity index improvers, and pour point depressants,

wherein said lubricating oil has a total base number of less than 10, and (a) a sulfur content less than 0.3 wt%, (b) a phosphorus content of less than 0.1 wt%, and (c) an ash content less than 1.2 wt%.

2. A lubricating oil according to claim 1, wherein the additive package comprises:

at least one alkylamine salt of a dialkylmonothiophosphate; and

(i) at least one detergent, wherein the weight ratio of said alkylamine salt of a dialkylmonothiophosphate to said detergent is from 0.05:1 to 3:1, or
(ii) at least one dispersant, wherein the weight ratio of said alkylamine salt of a dialkylmonothiophosphate to said dispersant is from 1:4 to 1:20, or
(iii) at least one antioxidant, wherein the weight ratio of said alkylamine salt of a dialkylmonothiophosphate to antioxidant is from 10:1 to 1:5.

3. A lubricating oil according to claim 2, wherein the additive package comprises at least one detergent selected from calcium sulfonate, magnesium sulfonate, sodium sulfonate, non-sulfurized Mannich phenates, sulfurized phenates, salicylates, overbased saligenin, and combinations thereof.

4. A lubricating oil according to claim 2 or 3, wherein the additive package comprises at least one dispersant having a molecular weight of from 1000 to 20000.

5. A lubricating oil according to claim 4, wherein said at least one dispersant is a maleic anhydride functionalized polyisobutylene polymer that has been reacted with a polyamine, or a product of a Mannich reaction or is an ethylenepropylene type dispersant.

6. A lubricating oil according to any one of claims 2 to 5, wherein the additive package additionally comprises at least one component selected from viscosity index improvers and pour point depressants.

7. A lubricating oil according to any one of claims 2 to 6, wherein the additive package comprises at least one antioxidant selected from alkylated diphenylamines, sulfurized olefins, phenols, hindered phenols, and sulfurized phenol.

8. A lubricating oil according to claim 1, wherein said oil soluble lubricant additive package is free of sulfurized phenate.

9. A method for lubricating an engine crankcase, said method comprising the step of:

at least partially filling said crankcase with a lubricant oil as defined in any one of claims 1 to 8.

10. A method for lubricating moving parts of a machine, said method comprising the step of :

contacting at least one said moving part with a lubricant oil as defined in any one of claims 1 to 8.

11. A method according to claim 10 wherein said machine is selected from gas engines, diesel engines, turbine engines, automatic transmissions, manual transmissions, hypoid axles, and gear boxes.

12. A method of achieving a low sulfur, low ash, and low phosphate oil formulation, said method comprising:

providing an oil soluble lubricant additive package as defined in any one of claims 1 to 8, and
admixing said oil soluble lubricant additive package with at least a base oil so as to form a lubricating oil as defined in claim 1.

Patentansprüche

1. Schmieröl, welches zum Schmieren eines Kurbelgehäuses geeignet ist, umfassend eine öllösliche Schmiermitteladditivpackung, wobei die Additivpackung umfasst:

(a) ein Alkylaminsalz eines Dialkylmonothiophosphats; und
(b) mindestens eine Komponente, ausgewählt aus Detergenzien, Dispergiermitteln, Antioxidationsmitteln, Rei-

bungsmodifizierungsmitteln, Mitteln zur Verbesserung des Viskositätsindexes und Fließpunkterniedrigungsmitteln,

wobei das Schmieröl eine Maßzahl für den Alkaligehalt (total base number) von niedriger als 10 und (a) einen Schwefelgehalt von niedriger als 0,3 Gew.-%, (b) einen Phosphorgehalt von niedriger als 0,11 Gew.-% und (c) einen Aschegehalt von niedriger als 1,2 Gew.-% aufweist.

2. Schmieröl gemäß Anspruch 1, wobei die Additivpackung umfasst:

mindestens ein Alkylaminsalz eines Dialkylmonothiophosphats; und

(i) mindestens ein Detergenz, wobei das Gewichtsverhältnis des Alkylaminsalzes eines Dialkylmonothiophosphats zu dem Detergenz 0,05:1 bis 3:1 beträgt, oder
(ii) mindestens ein Dispergiermittel, wobei das Gewichtsverhältnis des Alkylaminsalzes eines Dialkylmonothiophosphats zu dem Dispergiermittel 1:4 bis 1:20 beträgt, oder
(iii) mindestens ein Antioxidationsmittel, wobei das Gewichtsverhältnis des Alkylaminsalzes eines Dialkylmonothiophosphats zu Antioxidationsmittel 10:1 1 bis 1:5 beträgt.

3. Schmieröl gemäß Anspruch 2, wobei die Additivpackung mindestens ein Detergenz, ausgewählt aus Calciumsulfonat, Magnesiumsulfonat, Natriumsulfonat, nicht-sulfurierten Mannich-Phenolaten, sulfurierten Phenolaten, Salicylaten, überbasischem Saligenin und Kombinationen davon, umfasst.

4. Schmieröl gemäß Anspruch 2 oder 3, wobei die Additivpackung mindestens ein Dispergiermittel mit einem Molekulargewicht von 1000 bis 20000 umfasst.

5. Schmieröl gemäß Anspruch 4, wobei das mindestens eine Dispergiermittel ein Maleinsäureanhydrid-funktionalisiertes Polyisobutylenpolymer, welches mit einem Polyamin umgesetzt wurde, oder ein Produkt einer Mannich-Reaktion ist oder ein Dispersantmittel vom Ethylen-Propylen-Typ ist.

6. Schmieröl gemäß einem der Ansprüche 2 bis 5, wobei die Additivpackung zusätzlich mindestens eine Komponente, ausgewählt aus Mitteln zur Verbesserung des Viskositätsindexes und Fließpunkterniedrigungsmitteln, umfasst.

7. Schmieröl gemäß einem der Ansprüche 2 bis 6, wobei die Additivpackung mindestens ein Antioxidationsmittel, ausgewählt aus alkylierten Diphenylaminen, sulfurierten Olefinen, Phenolen, gehinderten Phenolen und sulfurierten Phenolen, umfasst.

8. Schmieröl gemäß Anspruch 1, wobei die öllösliche Schmiermitteladditivpackung frei von sulfuriertem Phenolat ist.

9. Verfahren zum Schmieren eines Kurbelgehäuses, wobei das Verfahren den folgenden Schritt umfasst:

das mindestens teilweise Füllen des Kurbelgehäuses mit einem Schmiermittelöl wie in einem der Ansprüche 1 bis 8 definiert.

10. Verfahren zum Schmieren von sich bewegenden Teilen einer Maschine, wobei das Verfahren den folgenden Schritt umfasst:

das Inkontaktbringen von mindestens einem der genannten sich bewegenden Teile mit einem Schmiermittelöl wie in einem der Ansprüche 1 bis 8 definiert.

11. Verfahren gemäß Anspruch 10, wobei die Maschine aus Gasmotoren, Dieselmotoren, Turbinenmotoren, automatischen Getrieben, manuellen Getrieben, Hypoidachsen und Gangschaltungen ausgewählt ist.

12. Verfahren zum Erreichen einer Ölformulierung mit niedrigem Schwefelgehalt, niedrigem Aschegehalt und niedrigem Phosphatgehalt, wobei das Verfahren umfasst:

das Bereitstellen einer öllöslichen Schmiermitteladditivpackung wie in einem der Ansprüche 1 bis 8 definiert, und das Mischen der öllöslichen Schmiermitteladditivpackung mit mindestens einer Ölgrundlage, um so ein Schmieröl wie in Anspruch 1 definiert zu bilden.

Revendications

1. Huile lubrifiante propre à lubrifier un carter de moteur, comprenant un paquet d'additifs oléosolubles pour lubrifiant, lequel paquet d'additifs comprend :

   a) un sel d'alkylamine d'un monothiophosphate de dialkyle,
   b) et au moins un composant choisi parmi les détergents, dispersants, anti-oxydants, agents modifiant le frottement, agents améliorant l'indice de viscosité, et agents abaissant le point d'écoulement,

   et laquelle huile lubrifiante présente un indice de basicité totale inférieur à 10, et (a) une teneur en soufre de moins de 0,3 % en poids, (b) une teneur en phosphore de moins de 0,11 % en poids, et (c) une teneur en cendres de moins de 1,2 % en poids.

2. Huile lubrifiante conforme à la revendication 1, dans laquelle le paquet d'additifs comprend :

   au moins un sel d'alkylamine d'un monothiophosphate de dialkyle, et

   i) au moins un détergent, en un rapport en poids dudit sel d'alkylamine d'un monothiophosphate de dialkyle audit détergent valant de 0,05/1 à 3/1,
   ii) ou au moins un dispersant, en un rapport en poids dudit sel d'alkylamine d'un monothiophosphate de dialkyle audit dispersant valant de 1/4 à 1/20,
   i) ou au moins un anti-oxydant, en un rapport en poids dudit sel d'alkylamine d'un monothiophosphate de dialkyle audit anti-oxydant valant de 10/1 à 1/5.

3. Huile lubrifiante conforme à la revendication 2, dans laquelle le paquet d'additifs comprend au moins un détergent choisi parmi les sulfonates de calcium, sulfonates de magnésium, sulfonates de sodium, phénates de Mannich non sulfurés, phénates sulfurés, salicylates, et saligénine hyper-alcalinisée, et leurs combinaisons.

4. Huile lubrifiante conforme à la revendication 2 ou 3, dans laquelle le paquet d'additifs comprend au moins un dispersant dont la masse molaire vaut de 1000 à 20000.

5. Huile lubrifiante conforme à la revendication 4, dans laquelle ledit dispersant au nombre d'au moins un est un produit de réaction d'une polyamine et d'un polymère de type polyisobutylène fonctionnalisé avec de l'anhydride maléique, ou bien un produit d'une réaction de Mannich, ou encore un dispersant de type éthylène-propylène.

6. Huile lubrifiante conforme à l'une des revendications 2 à 5, dans laquelle le paquet d'additifs comprend en outre au moins un composant choisi parmi les agents améliorant l'indice de viscosité et les agents abaissant le point d'écoulement.

7. Huile lubrifiante conforme à l'une des revendications 2 à 6, dans laquelle le paquet d'additifs comprend au moins un anti-oxydant choisi parmi les diphényl-amines alkylées, oléfines sulfurées, phénols, phénols encombrés, et phénols sulfurés.

8. Huile lubrifiante conforme à la revendication 1, dans laquelle ledit paquet d'additifs oléosolubles pour lubrifiant ne contient pas de phénates sulfurés.

9. Procédé visant à lubrifier un carter de moteur, lequel procédé comporte une étape consistant à remplir, au moins en partie, ledit carter avec une huile lubrifiante conforme à l'une des revendications 1 à 8.

10. Procédé visant à lubrifier des pièces mobiles d'une machine, lequel procédé comporte une étape consistant à mettre au moins l'une de ces pièces mobiles en contact avec une huile lubrifiante conforme à l'une des revendications 1 à 8.

11. Procédé conforme à la revendication 10, dans lequel ladite machine est choisie parmi les moteurs à gaz, moteurs Diesel, moteurs à turbine, transmissions automatiques, transmissions manuelles, essieux à engrenages hypoïdes et boîtes de vitesse.

12. Procédé de réalisation d'une formulation d'huile à basses teneurs en soufre, en cendres et en phosphates, lequel procédé comporte :

- le fait de prendre un paquet d'additifs oléosolubles pour lubrifiant, du type défini dans l'une des revendications 1 à 8,
- et le fait de mélanger ce paquet d'additifs oléosolubles pour lubrifiant avec au moins une huile de base, de manière à en faire une huile lubrifiante conforme à la revendication 1.

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