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(54) Turbine and R&O oils containing neutral rust inhibitors

(57) A composition suitable for use as a turbine or rust and oxidation (R&G) oil comprising a major portion of a base oil and (A) at least one neutral rust inhibitor, wherein the base oil has a viscosity index of greater than 80, a saturates content of greater than 90 wt% and a sulfur content of 0.5 wt% or less providing improved filterability.

Further improved hydrolytic stability may be obtained by the addition of (B) a compound of the formula:

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Description

[0001] The present invention relates to turbine and rust and oxidation (R&O) oils (hereinafter "turbine oils") having improved wet filterability without detriment to hydrolytic stability.

[0002] Steam and gas turbine oils are top-quality rust- and oxidation-inhibited oils. Steam turbines employ steam that enters the turbine at high temperature and pressure and expands across both rotating and fixed blades. Only the highest-quality lubricants are able to withstand the wet conditions, high temperatures and long periods of service associated with steam turbine operation. In gas turbines, they must withstand contact with very hot surfaces, often with intermittent operation and periods of nonuse. Therefore, to be effective, both types of oil must have, in addition to good corrosion protection and demulsibility, outstanding resistance to oxidation, which includes a minimum tendency to form deposits in critical areas of the system.

[0003] To achieve these desired properties, it is necessary to formulate these oils from specially refined base stocks of the highest quality plus a carefully balanced additive package. The nature of these fluids makes them very susceptible to contamination, particularly from other lubricants and additives. A relatively small degree of contamination can markedly affect the properties and expected service life of these lubricants. Further, to maintain effective operating conditions and to avoid damaging the equipment in which they are used, turbine oils should be kept meticulously clean and free of contaminants. Contamination is minimized by filtration of the turbine oils. To ensure that the turbine oils are substantially free of contaminants very fine filters are used.

[0004] Due to the requirements of turbine oils, only a few classes of additives, relative to other types of lubricating compositions, are combined with the base oils. Generally, a finished turbine oil will contain only the base oil, antioxidants, rust inhibitors, demulsifiers, corrosion inhibitors and diluents, if necessary.

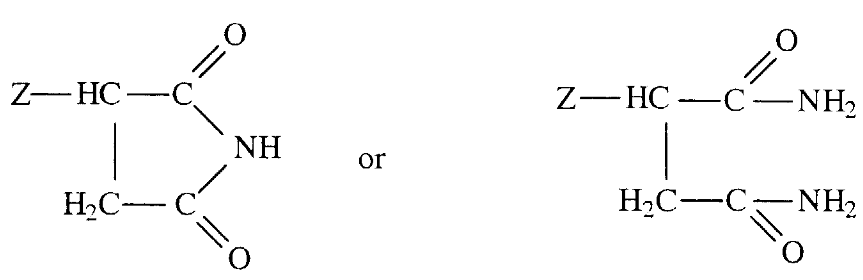
[0005] Prior art turbine oils contain acidic rust inhibitors. For example, acidic rust inhibitors, of the type taught in U. S. Patent No. 4,101,429, have been used in turbine oils. Although, turbine oils containing acidic rust inhibitors exhibit satisfactory rust performance, they tend to interact with, for example, water and metal detergents present as contaminants producing particulates, precipitates and/or sludge. Acidic rust inhibitors thus create problems with deposit formation and filterability upon exposure to contaminants such as water and/or metal detergents. The resulting filterability problems and deposit formation are expensive and highly undesirable.

[0006] It is an object of this invention to provide turbine oils that exhibit good rust performance as well as good wet filterability and good thermal stability upon exposure to contaminants such as water and/or detergents. This objective is obtained, in one embodiment of the present invention, by the use of neutral rust inhibitors, in place of acidic rust inhibitors, in preparing the finished turbine oils. Accordingly, the present invention provides a composition suitable for use as a turbine or rust and oxidation (R & O) oil comprising a major portion of a base oil and (A) at least one neutral rust inhibitor, wherein the base oil has a viscosity index of greater than 80, a saturates content of greater than 90 wt% and a sulfur content of 0.5 wt% or less. Those skilled in the art will appreciate that such oils are commonly referred to as Group II, Group III or Group IV oils. The viscosity index is assessed in accordance with IP 226. The saturates and sulfur content are assessed by mass spectroanalysis.

[0007] The term "neutral rust inhibitors", in the present specification, means rust inhibitors that are essentially free of a -COOH functional group.

[0008] The term "major portion" means that the composition contains at least 50% by weight base oil.

[0009] In another embodiment of the present invention, a combination of neutral rust inhibitor(s) and a compound (B) of formula:



in which Z is a group R_1R_2CH-, in which R_1 and R_2 are each independently hydrocarbon groups containing from 1 to 34 carbon atoms, the total number of carbon atoms in the groups R_1 and R_2 being from 11 to 35, are added to the base oil in order to provide a turbine oil which ensures good rust performance, good wet filterability and good performance in thermal stability tests where water and/or metal detergents are present, e.g. the ASTM D 2619 and ASTM D 4310 tests.

[0010] Unless otherwise stated all hydrocarbyl groups and moieties may be straight- or branched-chain.

[0011] In another embodiment of the present invention, turbine oils are produced which are substantially free of acidic rust inhibitors and/or metal detergents. For purposes of the present invention, the term "substantially free" means that no acidic rust inhibitors or metal detergents are purposefully added to the finished oil although there may be some present due to contamination or as an impurity.

[0012] Preferably, the at least one neutral rust inhibitor is a hydrocarbyl ester of formula R (COOR')$_n$, in which R and R' are each independently hydrocarbyl groups, or hydroxyhydrocarbyl groups, containing upto about 40 carbon atoms, preferably 8 to 20 carbon atoms, and n is from 1 to about 4.

[0013] It will be appreciated that the maximum number of groups COOR' which are present on the hydrocarbyl or hydroxyhydrocarbyl group R will vary depending on the number of carbon atoms in R. For example, if R is a hydrocarbyl group containing only one carbon atom, the maximum possible value of n will be 4. When R is a hydroxyhydrocarbyl group containing one carbon atom the maximum value of n will be 3.

[0014] The hydrocarbyl esters can be prepared by conventional esterification procedures from a suitable alcohol and an acid, acid halide, acid anhydride or mixtures thereof. Also, the esters of the invention can be prepared by conventional methods of transesterification. By "essentially free", it is meant that the starting acids, acid halides, acid anhydrides or mixtures thereof used in preparing the neutral rust inhibitors are reacted with an amount of alcohol sufficient to theoretically convert all of the -COOH groups to esters. Typically, the neutral rust inhibitor will have a TAN of less than 10mgKOH/g. Preferred esters include, but are not limited to, octyloleyl malate, dioleylmalate, pentaerythritol monooleate and glycerol monooleate.

[0015] Another class of preferred neutral rust inhibitors includes aspartic acid diesters of 1-(2-hydroxyethyl)-2-heptadecenyl imidazoline. This imidazoline is primarily a mixture of diester of L-aspartic acid and an imidazoline based on the reaction between oleic acid and aminoethanolamine. Esters of this type are commercially available from Mona Industries, Inc. as Monacor® 39.

[0016] In compound (B) the radical Z may be, for example, 1-methylpentadecyl, 1-propyltridecenyl, 1-pentyltridecenyl, 1-tridecenylpentadecenyl or 1-tetradecyleicosenyl. Preferably, the number of carbon atoms in the groups R_1 and R_2 is from 16 to 28 and more commonly 18 to 24. It is especially preferred that the total number of carbon atoms in R_1 and R_2 is about 20 to 22. The preferred compound (B) is 3-C_{18-24} alkenyl-2,5-pyrrolidindione, i.e. a compound in which the average number of carbon atoms in the alkenyl group is from 18 to 24.

[0017] In one aspect of the invention, the compound (B) has a titratable acid number (TAN) of about 80 to about 140 mgKOH/g, preferably about 110mgKOH/g. The TAN is determined in accordance with ASTM D 664.

[0018] The compounds (B) are commercially available or may be made by the application or adaptation of known techniques (see for example EP-A-0389237).

[0019] Lubricating oils contemplated for use in this invention 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 (rather than solvent extracting) the aromatic and polar components of crude oil. In general, both the natural and synthetic lubricating oils will each have a kinematic viscosity ranging from about 1 x 10^{-6} m^2/s to about 40 x 10^{-6} m^2/s (about 1 to about 40 cSt) at 100º C, although typical applications will require each oil to have a viscosity ranging from about 2 x 10^{-6} m^2/s to about 8 x 10^{-6} m^2/s (about 2 to about 8 cSt) at 100º C.

[0020] Natural base 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 base oil is mineral oil.

[0021] The mineral oils useful in this invention include 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 they may be extracted oils produced, for example, by solvent extraction with solvents such as phenol, sulfur dioxide, furfural, dichlordiethyl ether, etc. They may be hydrotreated or hydro-refined, 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.

[0022] Typically the mineral oils will have kinematic viscosities of from 2 x 10^{-6} m^2/s to 12 x 10^{-6} m^2/s (2 cSt to 12 cSt) at 100°C. The preferred mineral oils have kinematic viscosities of from 3 x 10^{-6} m^2/s to 10 x 10^{-6} m^2/s (3 to 10 cSt), and most preferred are those mineral oils with viscosities of 5 x 10^{-6} m^2/s to 9 x 10^{-6} m^2/s (5 to 9 cSt) at 100°C.

[0023] Synthetic lubricating oils useful in this invention include hydrocarbon oils and halo-substituted hydrocarbon oils such as oligomerized, polymerized, and interpolymerized olefins [e.g., polybutylenes, polypropylenes, propylene, isobutylene copolymers, chlorinated polylactenes, poly(1-hexenes), poly(1-octenes), and mixtures thereof]; alkylbenzenes [e.g., polybutylenes, polypropylenes, propylene, isobutylene copolymers, chlorinated polylactenes, poly (1-hexenes), poly (1-octenes) and mixtures thereof]; alkylbenzenes [e.g., dodecylbenzenes, tetradecylbenzenes, dinonyl-benzenes and di(2-ethylhexyl)benzene]; polyphenyls [e.g., biphenyls, terphenyls, alkylated polyphenyls]; and alkylated diphenyl ethers, alkylated diphenyl sulfides, as well as their derivatives, analogs, and homologs thereof, and the like. The preferred synthetic oils are oligomers of α-olefins, particularly oligomers of 1-decene, also known as polyalpha olefins or PAO's.

[0024] Synthetic lubricating oils also include alkylene oxide polymers, interpolymers, copolymers, and derivatives thereof where the terminal hydroxyl groups have been modified by esterification or etherification. 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).

[0025] 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, suberic acid, sebacic acid, fumaric acid, adipic acid, linoleic acid dimer, malonic acid, alkylmalonic acids and alkenyl malonic acids) with a variety of alcohols (e.g., butyl alcohol, hexyl alcohol, dodecyl alcohol, 2-ethylhexyl alcohol, ethylene glycol, diethylene glycol monoethers and propylene glycol). Specific examples of these esters include dibutyl adipate, di(2-ethylhexyl) sebacate, di-n-hexyl fumarate, dioctyl sebacate, diisooctyl azelate, diisodecyl azelate, dioctyl isophthalate, 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-ethyl-hexanoic acid. A preferred type of oil from this class of synthetic oils are adipates of C_4 to C_{12} alcohols.

[0026] 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 pentaerythritol, dipentaerythritol and tripentaerythritol.

[0027] 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, tetraisopropyl silicate, tetra-(2-ethylhexyl) silicate, tetra-(4-methyl-2-ethylhexyl) silicate, tetra-(p-tert-butylphenyl) silicate, hexa-(4-methyl-2-pentoxy)-disiloxane, poly(dimethyl)-siloxanes and poly (methylphenyl) siloxanes. 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 and poly-α-olefins.

[0028] The lubricating base 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 a shale oil obtained directly from a retorting operation, a 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 oils breakdown products. White oils, as taught in U.S. 5,736,490 may also be used as the base oil for the turbine and R&O oil.

[0029] The base oils have a viscosity index (VI) of greater than 80, a saturates content of greater than 90 wt% and sulfur content of 0.5 wt% or less. In a preferred embodiment the oils have a sulfur content of 0.3 wt% or less, more preferably 0.1 wt% or less. The preferred base oils for use in the present invention are the hydroprocessed and/or isodewaxed mineral oil, synthetic oils and mixtures thereof.

[0030] The turbine and R&O oils of the present invention may be prepared by simple blending of the various components with a suitable base oil.

[0031] For the sake of convenience, and in a preferred embodiment of the present invention, the additive component (s) used in practice of this invention may be provided as a concentrate for formulation into a turbine or R&O oil ready for use. Concentrates of the present invention, containing neutral rust inhibitor(s), but no compound (B), are typically added to the base oil at a treat rate of about 0.5 to about 2%, for example about 0.7 to about 2%, by weight based on the weight of the finished oil. Concentrates of the present invention containing both neutral rust inhibitor(s) and compound (B) tend to impart greater rust protection in the presence of sea water (ASTM D665B) and are typically added to the base oil at a treat rate of from about 0.2 to about 2%, for example, about 0.3 to about 2%, by weight based on the weight of the finished oil.

[0032] When the neutral rust inhibitor(s) are used, without the addition of compound (B), they are generally present in the additive concentrate in an amount of from about 10 to about 60 percent by weight, based on the total weight of the concentrate. When used in combination with compound (B), the neutral rust inhibitor(s) are generally present in the additive concentrate in an amount of from 10 to 60 percent by weight, based on the total weight of the concentrate, while compound (B) is generally present in the additive concentrate in an amount of from about 1 to 15 percent by weight. The concentrate may comprise, in addition to the fluid components, a solvent or diluent for the fluid components. The solvent or diluent should be miscible with and/or capable of dissolving in the turbine base oil to which the concentrate is to be added. Suitable solvents and diluents are well known. The solvent or diluent may be the turbine base oil itself. The concentrate may suitably include any of the conventional additives used in turbine oils. The proportions of each component of the concentrate are controlled by the intended degree of dilution, though top treatment of the formulated fluid is possible.

[0033] Whether added directly to the base oil, or in the form of a concentrate, the neutral rust inhibitor(s) should be present in the finished oil in an amount of at least about 0.10, and preferably from 0.10 to about 0.45 percent by weight. Whether added directly to the base oil, or in the form of a concentrate, compound (B), if used, should be present in the finished oil in an amount of about 0.008 to about 0.25 percent by weight.

[0034] The additive concentrates and finished oils of the present invention may further contain additional additives such as phosphorus-containing additives and sulfurized esters. Preferred phosphorus containing additives include amine salts of acid phosphates and phosphorus and sulfur containing compounds.

[0035] Other additives commonly used in turbine and R&O oils may be included in the turbine and R&O oils of the present invention. These include antioxidants, demulsifiers and corrosion inhibitors. These additives, when present, are used in amounts conventionally used in turbine oil packages.

[0036] The invention will now be illustrated by the following Examples that are not intended to limit the scope of the invention in any way.

EXAMPLES

[0037] In Table 1, the formulations for various turbine oil concentrates are set forth. Turbine Oil Concentrates 1-4 represent formulations within the scope of the present invention, i.e., they contain neutral rust inhibitors and are substantially free of acidic rust inhibitor. Turbine Oil Concentrate 5 represents an additive concentrate outside of the scope of the present invention in that it contains an acidic rust inhibitor. All of the samples used similar conventional additives (e.g., antioxidants, demulsifiers and corrosion inhibitors) in similar amounts.

Table 1

Turbine Oil Concentrates					
	Turbine Oil 1 (TO1)	Turbine Oil 2 (TO2)	Turbine Oil 3 (TO3)	Turbine Oil 4 (TO4)	Turbine Oil 5 (TO5) (Comparative)
Rust Inhibitor V	21.25				
Rust Inhibitor W	0.50				
Rust Inhibitor X		22.50		22.50	
Rust Inhibitor Y			20.00		
Rust Inhibitor Z					12.00
Compound B				5.00	

RI V: Glycerol monooleate neutral rust inhibitor.
RI W: Ashless sulfonate neutral rust inhibitor.
RI X: Pentaerythritol monooleate neutral rust inhibitor.
RI Y: Octyloleyl malate neutral rust inhibitor.
RI Z: An acidic rust inhibitor comprising the reaction product of oleic acid, triethylene tetramine and maleic anhydride substituted by a C12 alkenyl group of the kind described in U.S. Patent No. 4,101,429.
Comp. B: 3-C_{18-24} alkenyl-2,5-pyrrolidindione.

[0038] Turbine oils are prepared by adding additive concentrates as described above to base oils of various viscosities at a treat rate of 0.8 percent by weight. The base oil used was a hydro-processed (HP) mineral oils having a VI of at least 98, a saturates level of at least 98% and a sulfur content of less than 0.01 wt%. A solvent refined (SR) base oil was also used. The finished oils were tested for wet filterability using the Shell Filtration Test and for rust performance using the ASTM D 665B rust test.

[0039] The Shell Filtration Test is intended to evaluate the filterability characteristics of oil based hydraulic fluids with and without calcium and/or water contamination. The fluids as blended and the contaminated fluids are each tested in duplicate as follows. After pre-treatment at 70 °C, 300 ml of test oil are filtered through a 1.2 micron Millipore membrane using a 650 mm Hg vacuum. The fluid temperature is not controlled but should be in the range of 19 to 26 °C. The times for each successive 100 ml of fluid to filter, or for the filter membrane to block, are noted. In the following Tables the results of the Shell Filtration Test are indicated as either PASS, meaning that all 300 ml of oil passed through the filter, or FAIL, meaning that the filter became blocked.

[0040] The results of the Shell Filtration Test and the ASTM D 665B rust test are set forth below in Table 2.

Table 2

Shell Filtration and ASTM D 665B Rust Test results			
Additive Concentrate	Base Oil - ISO #	Shell Filtration Test	D665B rust test
TO4	HP - 32	PASS	PASS
TO5	SR - 32	FAIL	PASS
TO5	SR - 46	FAIL	PASS
TO4	HP - 68	PASS	PASS
TO5	SR - 68	FAIL	PASS
TO4	HP - 100	PASS	PASS

[0041] It is clear from the above Table that compositions of the present invention exhibit both passing Shell Filtration results and ASTM D 665B results. Further, it is clear from the above Table 2 that turbine oils (TO5) containing sufficient amounts of acidic rust inhibitor to pass the ASTM D 665B rust test fail the Shell Filtration Test.

[0042] In handling, i.e., storing and transporting, of turbine oils, the turbine oil often comes into contact with residual lubricating fluids containing acidic rust inhibitors and/or metal detergents or turbine oils containing acidic rust inhibitors. The turbine oils of the present invention enable passing Shell Filtration Test results upon contamination with these sources of acidic rust inhibitors and/or metal detergents.

[0043] For some applications, oxidation performance in the presence of water is desired along with acceptable rust test performance. Turbine oils containing components (A) and (B) of the present invention have been found to exhibit excellent thermal stability in tests with water present and passing rust test performance. ASTM D 4310 is used to determine the tendency of inhibited mineral oils, especially turbine oils, to form sludge during oxidation in the presence of oxygen, water, and copper and iron metals at an elevated temperature. In this test, an oil sample is reacted with oxygen in the presence of water and an iron-copper catalyst coil for 1000 hours. The oil is then analysed to determine the total acid number (TAN), the weight of sludge and loss of copper and iron from the catalyst. Table 3 shows the hydrolytic stability in the presence of water of turbine oils containing the combination of additives (A) and (B) of the present invention.

[0044] The formulated oil included pentaerythritol monooleate at a concentration of 0.18 wt % and 3-C_{18-24} alkenyl-2,5-pyrrolidindione at a concentration of 0.04 wt%. The base oil was a hydro-processed basestock having a viscosity index of 99, a saturates content of 99.5 wt % and a sulfur content of 0.02 wt %.

Table 3

Sludge (mg)	Copper wt. change (mg)	Iron wt. change (mg)	TAN (mg/KOH g)
12.5	0.5	0.75	0.425

The results represent the average of 2 runs.

[0045] The additive combinations of the present invention are especially effective in hydro-processed mineral oils. Table 4 demonstrates the exceptional properties of the additive systems of the present invention in these hydro-processed mineral oils. The following formulated oils contained identical additive concentrates (TO4). The solvent refined mineral oils (SR-32 and SR-68) contained 0.82 wt% of TO4, while the hydro-processed mineral oils (HP-32, HP-68 and HP-100) contained 0.80 wt% of TO4. The formulated oils were tested in the Rotating Bomb Oxidation Test (RBOT) defined in ASTM D-2272. The RBOT is a test for estimating the oxidation stability of turbine oils. The test oil, water and copper catalyst coil, contained in a covered glass container, are placed in a bomb equipped with a recording pressure gauge. The bomb is charged with oxygen to a pressure of 620 kPa, placed in a constant-temperature oil bath set at 150 °C, and rotated axially at 100 rpm at an angle of 30° from the horizontal. The number of minutes required to reach a specific drop in gauge pressure is the oxidation stability of the test sample.

[0046] The formulated oils containing solvent refined basestocks were also tested in the Lifetime Turbine Oil Oxidation Test (Life TOST) as defined in ASTM D-943. The Life TOST is used to evaluate the oxidation stability of inhibited steam turbine oils. In the Life TOST, the oil sample is reacted with oxygen in the presence of water and an iron-copper catalyst at 95 °C. The test continues until the measured total acid number of the oil is 2.0 mg KOH/g. The number of test hours required for the oil to reach 2.0 mg KOH/g is the "oxidation lifetime". The RBOT for base oil alone would be in the region of 15-30 minutes.

Table 4

Base oil	RBOT (minutes)	Life TOST (hours)
SR-32	602.5 (avg. of 2 runs)	6188
HP-32	1199 (avg. of 3 runs)	
SR-68	707.5 (avg. of 2 runs)	6032
HP-68	1292 (avg. of 3 runs)	
HP-100	1253 (avg. of 3 runs)	

[0047] It is clear from Table 4 that the turbine oils prepared from hydro-processed mineral oils exhibit superior oxidation stability, compared to solvent refined mineral oils, as evidenced by the increased (nearly doubled) length of the RBOT for the turbine oils prepared from hydro-processed mineral oils. As is readily apparent from Table 4, the Life TOST for the turbine oils prepared from solvent refined mineral oils was over 250 days. Due to the extremely long test time for these oils the RBOT may be used as a tool to predict Life TOST results. In the paper Mookken, R.T. et al., *Dependence of Oxidation Stability of Steam Turbine Oil on base Oil Composition,* Lubrication Engineering, October 1997, pages 19-24, it was shown that the RBOT can be used as a screening test to get an indication of the TOST life of the blended turbine oil. The study shows that the RBOT and Life TOST are directly proportional. Thus, it is clear from Table 4 that the turbine oils prepared from hydro-processed mineral oils will exhibit superior oxidation stability as determined by Life TOST in view of their significantly longer RBOT life.

Claims

1. A composition suitable for use as a turbine or rust and oxidation (R&O) oil comprising a major portion of a base oil and (A) at least one neutral rust inhibitor, wherein the base oil has a viscosity index of greater than 80, a saturates content of greater than 90 wt% and a sulfur content of 0.5 wt% or less.

2. A composition according to claim 1, wherein the at least one neutral rust inhibitor is present in an amount of from about 0.10 to about 0.45% by weight.

3. A composition according to claim 1 or claim 2, wherein the at least one neutral rust inhibitor is a hydrocarbyl ester of formula $R(COOR')_n$, in which R and R' are each independently hydrocarbyl groups, or hydroxyhydrocarbyl groups, containing 1 upto about 40 carbon atoms, and n is from 1 to 4.

4. A composition according to claim 3, wherein R and R' are each independently hydrocarbyl groups, or hydroxyhydrocarbyl groups, containing 8 to 20 carbon atoms.

5. A composition according to claim 1 or claim 2, wherein the at least one neutral rust inhibitor is an aspartic diester

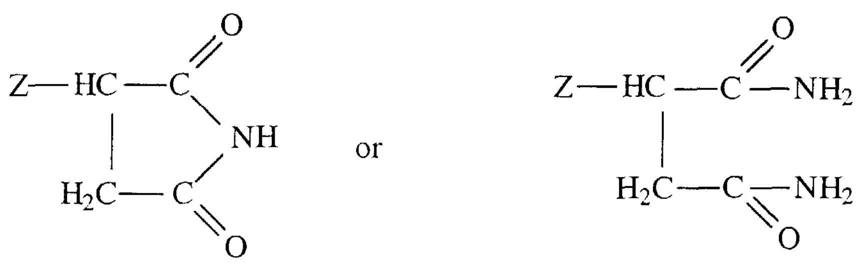
of 1-(2-hydroxyethyl)-2-heptadecenyl imidazoline.

6. A composition according to any one of the preceding claims, wherein the base oil is a natural oil, synthetic oil or mixture thereof.

7. A composition according to any one of the preceding claims, further comprising at least one additive selected from sulfurized esters, phosphorus-containing additives, phosphorus- and sulfur-containing additives, antioxidants, demulsifiers and corrosion inhibitors.

8. A composition according to any one of the preceding claims, which is substantially free of acidic rust inhibitor.

9. A composition according to any one of the preceding claims, further comprising (B) a compound of formula:



in which Z is a group R_1R_2CH-, in which R_1 and R_2 are each independently hydrocarbyl groups containing from upto 34 carbon atoms, the total number of carbon atoms in the groups R_1 and R_2 being from 11 to 35.

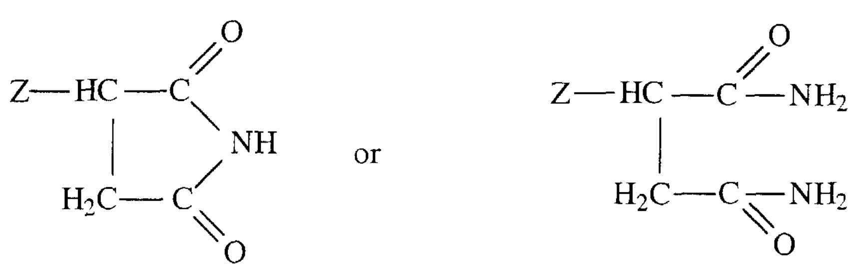
10. A composition according to claim 9, wherein in compound (B) the total number of carbon atoms in the groups R_1 and R_2 is 18 to 24.

11. A composition according to claim 9 or 10, wherein compound (B) is a 3-C_{18-24} alkenyl-2,5-pyrrolidindione.

12. A composition according to any one of the preceding claims, comprising from about 0.10 to about 0.45% by weight of (A) the at least one neutral rust inhibitor and from about 0.008 to about 0.25% by weight of compound (B).

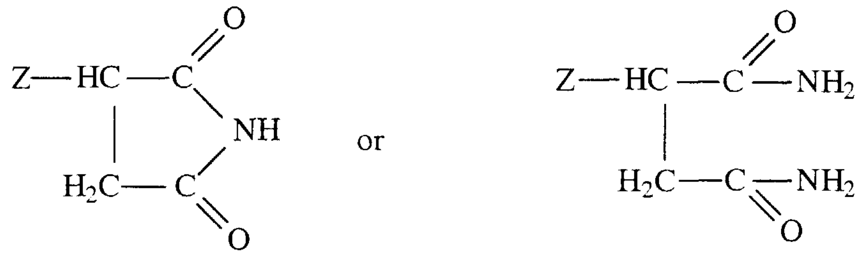
13. A method of improving the wet filterability of a turbine or rust and oxidation (R&O) base oil which has a viscosity index of greater than 80, a saturates content of greater than 90 wt% and a sulfur content of 0.5 wt% or less, which method comprises adding to the base oil (A) at least one neutral rust inhibitor.

14. A method according to claim 13, further comprising adding to the base oil (B) a compound of the formula:



in which Z is a group R_1R_2CH-, in which R_1 and R_2 are each independently hydrocarbyl groups containing from upto 34 carbon atoms, the total number of carbon atoms in the groups R_1 and R_2 being from 11 to 35.

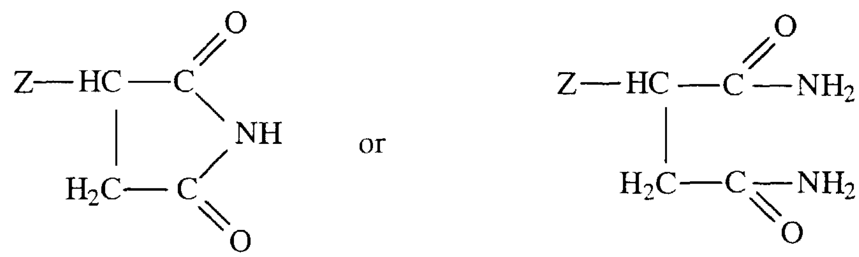
15. A method of improving the hydrolytic stability of a turbine or rust and oxidation (R&O) base oil which has a viscosity index of greater than 80, a saturates content of greater than 90 wt% and a sulfur content of 0.5 wt% or less, which method comprises adding to a base oil (A) at least one neutral rust inhibitor, and (B) a compound of the formula:



in which Z is a group R_1R_2CH-, in which R_1 and R_2 are each independently hydrocarbyl groups containing from 1 to 34 carbon atoms, the total number of carbon atoms in the groups R_1 and R_2 being from 11 to 35.

16. A method of reducing the formation of sludge, precipitates and/or particulates in a turbine or rust and oxidation (R&O) base oil containing water and/or metal detergents, the base oil having a viscosity index of greater than 80, a saturates content of greater than 90 wt% and a sulfur content of 0.5 wt% or less, which method comprises adding to the base oil at least one neutral rust inhibitor.

17. A method according to claim 16, further comprising adding to the base oil (B) a compound of formula:



in which Z is a group R_1R_2CH-, in which R_1 and R_2 are each independently hydrocarbyl groups containing from 1 to 34 carbon atoms, the total number of carbon atoms in the groups R_1 and R_2 being from 11 to 35.