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(71) Applicant: **TotalEnergies OneTech**
92400 Courbevoie (FR)

(72) Inventors:
- **CHAKRABORTY, Pankaj**
  69360 SOLAIZE (FR)
- **NEROUTSOU, Aimilia**
  69360 SOLAIZE (FR)

(74) Representative: **Plasseraud IP**
104 Rue de Richelieu
CS92104
75080 Paris Cedex 02 (FR)

(54) **LUBRICANT COMPOSITION COMPRISING REFINED BASE OIL**

(57) The present invention relates to an hydraulic oil composition comprising a Refined Base Oil and having a reduced Global Warming Potential.

EP 4 574 934 A1

Description

Technical Field

[0001] This disclosure pertains to the field of hydraulic oil compositions used to lubricate moving parts of a hydraulic system such as an air compressor. In particular, the present disclosure pertains to the use of refined base oil (RBO) for the formulation of hydraulic oil compositions.

Background Art

[0002] Lubricant compositions, also called "lubricant", are commonly used in the various components of mechanical systems such as, for example, hydraulic systems, industrial machinery or motor vehicles. Lubricant compositions mainly reduce friction forces between the various moving parts, in particular metal moving parts, of the components of mechanical systems. They are also effective in preventing premature wear or even damage to these moving parts, particularly their surfaces.

[0003] Hydraulic oil compositions are lubricant compositions intended to be used in hydraulic systems, in particular in hydrostatic hydraulic fluid power systems. Air compressor is an example of such hydraulic systems.

[0004] The technical properties of the hydraulic oil compositions have to meet a number of requirements, particularly with regard to the strict specifications imposed by the hydraulic systems manufacturers. For example, the hydraulic oil compositions must have satisfactory properties in terms of viscosity. These technical properties of the hydraulic oil composition are specified by ISO 11158:2023 HV.

[0005] Hydraulic oil compositions are typically composed of a base oil associated with one or more additives designed to boost the lubricating performance of the base oil but also to ensure that the technical properties of the compositions meet the requirements specified by ISO 11158:2023 HV.

[0006] Currently, the base oil of the hydraulic oil compositions is a conventional base oil (CBO) obtained from the refining of crude oils. A large quantity of crude oil is generally required to obtain conventional base oil. Typically, to extract 1 liter of conventional base oil, 37 liters of crude oil are required. In addition, oil refining processes are very energy-intensive and generate the emission of large quantities of carbon dioxide. The carbon footprint of the currently used hydraulic oil compositions therefore does not match the current environmental concerns and resource conservation issues.

[0007] Therefore, there is a need for a hydraulic oil composition having technical properties that meet the requirements specified by ISO 11158:2023 HV while having a reduced carbon footprint.

Summary

[0008] The present invention therefore covers a hydraulic oil composition comprising:

- a base oil comprising more than or equal to 5% or more by weight, based on the total weight of said hydraulic oil composition, of a Refined Base Oil and 95% or less by weight of a Conventional Base Oil,
- a viscosity modifier,

characterized in that the content of viscosity modifier in the hydraulic oil composition is reduced by at least 5% compared to the content of viscosity modifier needed to be added in a comparative hydraulic oil composition in which all the Refined Base Oil is replaced by a Conventional Base Oil, to maintain the technical properties of the hydraulic oil composition as requested by ISO specification 11158:2023 HV.

[0009] The use of a Refined Base Oil to formulate an hydraulic oil composition was never suggested in the prior art. The inventors demonstrated that the replacement, partial or total, of the Conventional Base Oil by a Refined Base Oil in a hydraulic oil composition comprising a viscosity modifier proved to be surprisingly advantageous from an ecological and technical point of view.

[0010] Indeed, the hydraulic oil composition of the invention, while meeting the technical requirement of ISO specification 11158:2023 HV, have a carbon footprint which is significantly lower than the carbon footprint of a conventional hydraulic oil composition comprising a base oil consisting of a Conventional Base Oil, thanks to the replacement, partial or total, by the Refined Base Oil of the Conventional Base Oil obtained from the refining of crude oil.

[0011] The lower carbon footprint of the hydraulic oil composition of the invention can also be explained by the reduction of the content of viscosity modifier, which is conventionally synthesized from fossil fuel.

[0012] This reduction of the carbon footprint of the hydraulic oil composition of the invention can be quantified by a reduction of the Global-Warming Potential of the hydraulic oil composition in comparison to the Global Warming Potential of the comparative hydraulic oil composition in which all the RBO is replaced by a CBO, while maintaining the technical properties of the hydraulic oil composition as requested by ISO specification 11158:2023 HV.

Indeed, the Global-Warming Potential is a used to describe the relative potency, molecule for molecule, of all the substances contributing to the greenhouse effect. The lower the Global Warming Potential, the lower the carbon footprint. The Global Warming Potential can be determined by the IPCC 2021 regulation.

In comparison to the Global Warming Potential of the comparative hydraulic oil composition in which all the RBO is replaced by a CBO, while maintaining the technical properties of the hydraulic oil composition as requested by ISO specification 11158:2023 HV, the Global Warming Potential of the hydraulic oil composition of the invention may be reduced by at least 10%, in particular by at least 25%, more particularly reduced by 40% to 50%.

[0013] Moreover, the replacement, partial or total, of the Conventional Base Oil by the Refined Base Oil combined with the reduced content of viscosity modifier surprisingly improves the shear stability, the demulsibility and the wet filterability of the hydraulic oil composition.

[0014] These technical improvements may result in additional ecological improvements.

[0015] For example, the lifetime of the hydraulic oil composition of the present invention is increased thanks to its improved shear stability and wet filterability. Accordingly, the duration between two maintenance operations of the hydraulic system using the hydraulic oil composition of the present invention can be longer than the duration between two maintenance operations of the hydraulic system using the conventional hydraulic oil composition.

[0016] Moreover, the lifetime of the moving parts of the hydraulic system lubricated by the hydraulic oil composition of the present invention is increased thanks to the improved demulsibility of the hydraulic oil composition of the present invention. The hydraulic oil composition of the present invention thus allows to extend the period of time between the replacement of the moving parts.

[0017] Furthermore, thanks to these technical improvements, the hydraulic system using the hydraulic oil composition of the present invention can be operated in its optimum performance range for longer period without the need for maintenance operation, *i.e.* the performance of said hydraulic system are optimized.

Therefore, during its lifetime, the hydraulic system using the hydraulic oil composition of the present invention has, advantageously,

- an increased lifetime since the lifetime of its moving parts is increased, and
- a reduced carbon footprint since it needs:
  - less hydraulic oil composition and less moving parts to be operated, and
  - less energy to be operated thanks to its optimized performance.

[0018] In another aspect, it is proposed an hydraulic oil composition comprising:

- a base oil comprising more than or equal to 5% or more by weight, based on the total weight of said hydraulic oil composition, of a Refined Base Oil and 95% or less by weight of a Conventional Base Oil
- a viscosity modifier,

characterized in that the content of viscosity modifier in the hydraulic oil composition is less than 8.5 % by weight based on the total weight of said hydraulic oil composition, in particular from 5% to 8%, more particularly from 7.5% to 7.7%.

[0019] In another aspect, it is proposed the use of one of the hydraulic oil compositions of the present invention for lubricating moving parts of an hydraulic system, in particular of a hydrostatic hydraulic fluid power system, more particularly of an air compressor.

[0020] In another aspect, it is proposed the use of a Refined Base Oil to formulate or manufacture an hydraulic oil composition.

[0021] In another aspect, it is proposed the method for manufacturing an hydraulic oil composition comprising at least a step of obtaining a Refined Base Oil from a used lubricant composition.

[0022] In another aspect, it is proposed a method of lubricating an hydraulic system comprising the following step:

a) contacting moving parts of the hydraulic system needing an hydraulic oil composition to be lubricated with the hydraulic oil composition of the present invention.

Description of Embodiments

[0023] The expressions "between ... and ..." and " from ... to ..." are to be understood inclusive, unless otherwise stated In the description and examples, unless otherwise indicated, percentages are percentages by weight. Percentages are therefore expressed by mass in relation to the total mass of the composition.

[0024] In a first aspect, it is proposed an hydraulic oil composition comprising:

- a base oil comprising more than or equal to 5% or more by weight, based on the total weight of said hydraulic oil composition, of a Refined Base Oil (RBO) and 95% or less by weight of a Conventional Base Oil (CBO),
- a viscosity modifier,

characterized in that the content of viscosity modifier in the hydraulic oil composition is reduced by at least 5% compared to the content of viscosity modifier needed to be added in a comparative hydraulic oil composition in which all the Refined Base Oil is replaced by a Conventional Base Oil, to maintain the technical properties of the hydraulic oil composition as requested by ISO specification 11158:2023 HV.

[0025] For the purposes of the present application, the expression "hydraulic oil composition" refers to a composition used to lubricate the moving parts of an hydraulic system and having technical properties meeting the requirements of ISO specification 11158:2023 HV.

[0026] For the purposes of the present application, the expression "Refined Base Oil" (also referred as RBO in the present application) refers to an oil derived at least in part from a used lubricant composition that has been subjected to one or more treatment steps known as re-refining treatment.

[0027] For the purposes of the present application, the expression "Conventional Base Oil" (also referred as CBO in the present application) refers to an oil which, as opposed to the RBO, is conventionally in the lubricant field that, is obtained directly from the refining of crude oil and has not yet been used.

[0028] For the purposes of the present application, the expression "viscosity modifier" refers to a chemical component that reduces the influence of temperature on the viscosity of the hydraulic oil composition.

[0029] For the purposes of the present application, the expression "used lubricant composition" means any lubricant composition that has been used to lubricate moving parts, in particular metal parts, of a mechanical system, such as bearings, gears or motors. The mechanical system can be an hydraulic system, an industrial machinery or a motor vehicle.

[0030] For the purposes of the present application, the expression "maintain the technical properties" means that:

- the technical properties of the hydraulic oil composition of the present invention and the technical properties of the comparative hydraulic oil meet the requirements of ISO specification 11158:2023 HV, and
- the absolute difference between the technical properties of the hydraulic oil composition of the present invention and the technical properties of the comparative hydraulic oil is less than 10%, in particular less than 5%, more particularly less than 1%.

[0031] The technical property of the hydraulic oil composition according to the present invention requested by ISO specification 11158:2023 HV may be a kinematic viscosity at 40°C higher than 46 mm^2/s, in particular higher than 46 mm^2/s and lower than or equal to 50 mm^2/s, more particularly from 47 mm^2/s to 49 mm^2/s.

[0032] The technical property of the hydraulic oil composition according to the present invention requested by ISO specification 11158:2023 HV may be a viscosity index higher than 160, in particular from 161 to 170, more particularly from 164 to 166.

[0033] An hydraulic oil composition having a kinematic viscosity at 40°C and/or a viscosity index within these ranges fulfils the requirements of ISO specification 11158:2023 HV and may be used in a hydraulic system, in particular in a hydrostatic hydraulic fluid power system, more particularly in an air compressor.

[0034] The kinematic viscosity at 100°C of the hydraulic oil composition according to the present invention may be higher than 8.0 mm^2/s, in particular higher than 8.0 mm^2/s and lower than or equal to 9.0 mm^2/s, more particularly from 8.7 mm^2/s to 8.9 mm^2/s.

[0035] The kinematic viscosity at 100°C of the RBO may be from 3.0 mm^2/s to 10.0 mm^2/s, in particular from 4.0 mm^2/s to 7.5 mm^2/s, more particularly from 5.5 mm^2/s to 6.0 mm^2/s.

[0036] The kinematic viscosity at 40°C of the RBO may be from 25 mm^2/s to 40 mm^2/s, in particular from 30 mm^2/s to 35 mm^2/s, more particularly from 31.5 mm^2/s to 33.0 mm^2/s.

[0037] The viscosity index of the RBO may be from 110 to 150, in particular from 115 to 130, more particularly from 120 to 125.

[0038] The molar mass of the RBO may be from 350 g/mol to 600 g/mol, in particular from 400 g/mol to 500 g/mol, more particularly from 430 g/mol to 450 g/mol.

[0039] The pour point of the RBO may be from -40°C to 0°C, in particular from -35°C to -10°C, more particularly from -30°C to -15°C.

[0040] Methods for re-refining or reconditioning used lubricant compositions have been developed, in order to regenerate these compositions and enable their subsequent reuse as RBO. A RBO is thus an oil obtained after one or more treatment steps of a used lubricant composition, aimed at eliminating, at least in part, a certain number of contaminating elements present therein, such as dust, water, fuel, metallic elements, polycyclic aromatic hydrocarbons and other residues resulting from the degradation of the used lubricant composition and that are not wanted to formulate hydraulic oil composition.

[0041] Therefore, a RBO differs from a used lubricant composition, in particular due to the reduced content of certain undesirable contaminants, such as water, fuel, metallic elements or certain heteroatoms.

[0042] The sulfur content of the RBO may be from 5°ppm to 1500°ppm, in particular from 10°ppm to 1100°pmm, more particularly from 1000 ppm to 1050 ppm or from 20 ppm to 40 ppm.

[0043] The nitrogen content of the RBO may less than or equal to 100°ppm, in particular from 0°ppm to 75°ppm, more particularly from 1 ppm to 60 ppm.

[0044] The silicon content of the RBO may be less than or equal to 300 ppm, in particular from 1 ppm to 200 ppm.

[0045] The phosphorus content of the RBO may be less than or equal to 100 ppm, in particular from 0 ppm and 50 ppm, for example 0 ppm.

[0046] The chlorine content of the RBO may be less than or equal to 50 ppm, in particular from 0 ppm and 25 ppm, for example 0 ppm.

[0047] The content of sulfur, nitrogen, silicon, phosphorous and chlorine can be assessed by any method known to the person skilled in the art, for example by X-ray fluorescence (XRF), or by infrared or ultraviolet spectroscopy.

[0048] The characteristics of the RBO according to the invention may fulfil the criteria defined by the classification API for the base oil of groups I, II, III, IV and/or V, in particular of groups I, II and/or III, more particularly of groups I and/or II.

[0049] The used lubricant composition may be a mixture of several used lubricant compositions, from the same source or from several different sources.

[0050] Used lubricant compositions comprise, as a main component, one or more base oils conventionally used in the lubricant field, such as mineral oil, synthetic oil, natural oil or mixtures thereof.

The natural oils are of natural origin, for example from plants or animals, such as vegetable oil, animal oil, fish oil or mixtures thereof. Examples of natural oil are rapeseed oil, canola oil, tall oil, sunflower oil, soybean oil, hemp oil, olive oil, linseed oil, mustard oil, palm oil, peanut oil, castor oil, coconut oil, animal fats, and mixtures thereof.

The oils of mineral or synthetic origin that can be used as base oils conventionally used in the lubricant field may belong to the group I, the group II, the group III, the group IV and/or the group V of the classification API.

[0051] For example, the used lubricant composition may comprise at least one base oil of the group I, the group II, the group III, the group IV and/or the group V of the classification API conventionally used in the lubricant field.

[0052] In particular, the used lubricant composition from which the RBO of the hydraulic oil composition according to the invention is obtained may comprise at least 50% by weight of the base oil(s) conventionally used in the lubricant field relative to its total weight, in particular at least 60% by weight of base oil(s) conventionally used in the lubricant field, and more particularly from 60% to 99% by weight of base oil(s) conventionally used in the lubricant field.

[0053] Used lubricant compositions may contain one or more additives conventional in the field of lubricants, such as a passivation additive, a demusilfier additive, an antioxidant additive, an anti-wear additive, a defoamer additive, a calcium-based additive, an anti-corrosion additive, a friction-modifying additive, an extreme-pressure additive, a detergent, a pour point depressant (PPD) additive, a dispersant, or mixtures thereof.

[0054] Due to their origin, used lubricant composition may also include a number of degradation products derived from the oil itself or the additives and produced during the use of said used lubricant composition over a longer or shorter period of time. Used lubricant composition may also contain metal particles, metal oxides and other elements from the mechanical system. In particular, used lubricant compositions may contain a high level of undesirable elements, such as calcium (Ca), iron (Fe), magnesium (Mg), sodium (Na), nickel (Ni), phosphorus (P), silicon (Si), chlorine (Cl), zinc (Zn) etc.

[0055] The RBO of the present invention may be obtained by subjecting a used lubricant composition to one or more treatment steps among a dehydration step, a distillation step, a filtration step, an hydrogenation step, a liquid/liquid extraction step, a decantation step and/or a passage of the used lubricant composition over an adsorbent material, in particular a passage of the used lubricant composition over an adsorbent material.

[0056] The dehydration step removes any water present in the used lubricant composition. The dehydration step can be carried out by any method known to the skilled person, for example by distillation, evaporation, decantation, heating or passing a stream of hot air over the used lubricant composition. For example, the dehydration step can be carried out at a temperature of between 50°C and 250°C, preferably between 100°C and 200°C. In particular, it can be operated at a pressure of between 50,000 and 150,000 Pa, preferably at atmospheric pressure.

Advantageously, the RBO obtained by subjecting a used lubricant composition to a dehydration step comprises a water content of less than or equal to 10% by mass, in particular less than or equal to 5% by mass, in particular less than or equal to 2% by mass and more particularly less than or equal to 1% by mass, relative to the total mass of said RBO.

[0057] The distillation step can be carried out, preferably, after the dehydration step. The distillation step can be carried out by any technique known to the skilled person, such as atmospheric distillation or distillation under reduced pressure. The distillation step can be carried out, for example, at a temperature of between 100°C and 500°C, preferably between 200°C and 400°C, more preferably between 300°C and 380°C and at a pressure of between 25 and 2,000 Pa, preferably between 50 and 1,000 Pa, more particularly between 50 and 250 Pa.

[0058] The filtration step can be carried out before the dehydration step. The filtration step can be carried out by any

method known to the skilled person. The filtration step may or may not be a particulate filtration step. It may, for example, be carried out by diatomaceous earth-type systems.

[0059] The passage of the used lubricant composition over an adsorbent material can be carried out by flowing the used lubricant composition over an adsorbent support. Advantageously, the adsorbent material enables aromatic compounds, in particular polycyclic aromatic hydrocarbons (PAHs), to be selectively adsorbed. In particular, passage over an adsorbent material, preferably activated carbon, advantageously makes it possible to reduce the content of PAHs, notably chosen from chrysene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, benzo[e]pyrene, benzo[a]pyrene, dibenz[a,h]anthracene and/or benz[a]anthracene, in the used lubricant composition.

[0060] The flow rate of the used lubricant composition can be between 1m^3/h and 15 m^3/h, for example between 5 m^3/h and 10 m^3/h.

[0061] Adsorbent materials can include activated carbon, zeolites, clays or functionalized porous compounds. Activated carbon is preferred.

[0062] A content from 0.5 to 60 g of adsorbent material per liter of used lubricant composition, preferably between 0.5 g/L and 50 g/L, more preferably between 1 g/L and 50 g/L, more preferably between 1 g/L and 30 g/L, for example between 5 g/L and 60 g/L, more preferably between 5 g/L and 50 g/L is particularly adapted to activated carbon used as adsorbent material.

[0063] Preferably, the activated carbon is characterized by a density of between 200 and 500 kg/m^3, for example measured in accordance with ASTDM D2854.

[0064] Preferably, the activated carbon is a hard coal, preferably comprising from 70 to 95%, advantageously from 80 to 90%, by weight of carbon.

[0065] The passage of the used lubricant composition over an adsorbent material, preferably activated carbon, is advantageously preceded by the following preliminary steps:

- one or more distillation steps; and
- a filtration step, in particular a filtration step as defined above.

[0066] For example, the RBO according to the invention can be obtained from the treatment of a used lubricant composition according to the process described in document WO 2018/109208.

[0067] The hydrogenation step can be carried out by any technique known to the skilled person and generally consist of treating the lubricant oil with hydrogen generally in the presence of a hydrogenation catalyst. Such a catalyst may contain, for example, at least one oxide or sulfide of at least one Group VI metal and/or at least one Group VIII metal, such as molybdenum, tungsten, nickel or cobalt, and a support, for example alumina, silica-alumina or a zeolite.
The hydrogenation step may, preferably, follow a dehydration and/or a distillation step.

[0068] Liquid/liquid solvent extraction is advantageous for lightening dark-colored used oil, at least partially removing bad odor or aromatic compounds, in particular PAHs. The liquid/liquid extraction step can be carried out by any technique known to the skilled person. The liquid/liquid extraction step is generally performed in a mixer-settler or in an extraction column, using a suitable extraction solvent. Advantageously, the liquid/liquid solvent extraction step may, preferably, follow a dehydration and/or distillation step.

[0069] The decantation step can be carried out by any technique known to the skilled person.

[0070] The kinematic viscosity at 100°C of the CBO may be from 3.0 mm^2/s to 10.0 mm^2/s, in particular from 4.0 mm^2/s to 7.5 mm^2/s, more particularly from 5.5 mm^2/s to 6.0 mm^2/s.

[0071] The kinematic viscosity at 40°C of the CBO may be from 25 mm^2/s to 40 mm^2/s, in particular from 30 mm^2/s to 35 mm^2/s, more particularly from 31.5 mm^2/s to 33.0 mm^2/s.

[0072] The viscosity index of the CBO may be from 80 to 150, in particular from 115 to 130, more particularly from 120 to 125.

[0073] The CBO may be of the group I, II, III, IV and/or V of the classification API, in particular of the group II.

[0074] The base oil may comprise more than 50% by weight of RBO and less than 50% by weight of CBO, in particular more than 75% by weight of RBO and less than 25% by weight of CBO, more particularly more than 85% by weight of RBO and less than 15% by weight of CBO.

[0075] According to one embodiment, the base oil consists of RBO.

[0076] This embodiment is advantageous in terms of reduction of carbon footprint since the hydraulic oil composition according to this embodiment does not comprise CBO obtained from the refining of crude oil.

[0077] The content of viscosity modifier of the hydraulic oil composition may be less than 8.5 % by weight based on the total weight of said hydraulic oil composition, in particular from 5% to 8%, more particularly from 7.5% to 7.7%.

[0078] Advantageously, such content of viscosity modifier is low. The Inventors are even of the opinion that this content is lower than the content of viscosity modifier in the known hydraulic oil composition.

[0079] The hydraulic oil composition of the present invention may also comprise one or more additives.

[0080] The one or more additives may be a passivation additive, a demusilfier additive, an antioxidant additive, an anti-

wear additive, a defoamer additive, a calcium-based additive, an anti-corrosion additive, a friction-modifying additive, an extreme-pressure additive, a detergent, a pour point depressant (PPD) additive, a dispersant, or mixtures thereof, in particular an anti-corrosion additive, a passivation additive, a demusilfier additive, an antioxidant additive, an anti-wear additive, a pour point depressant (PPD) additive, a defoamer additive, a calcium based additive or mixtures thereof, more particularly a mixture of an anti-corrosion additive, a passivation additive, a demusilfier additive, an antioxidant additive, an anti-wear additive, a calcium based additive, a pour point depressant (PPD) additive and a defoamer additive.

[0081] The content of the one or more additives may be less than 1.5% by weight based on the total weight of the hydraulic oil composition of the present invention, in particular from 0.95% to 1%, more particularly from 0.98% to 0.99%.

[0082] For example, the hydraulic oil composition of the present invention may comprise:

from 0.9 % to 1% by weight, based on the total weight of the hydraulic oil composition of the present invention, of a mixture of an anti-corrosion additive, a passivation additive, a demusilfier additive, an antioxidant additive, an anti-wear additive, a calcium based additive, and
from 0.01 to 0.05% be weight, based on the total weight of the hydraulic oil composition of the present invention, of a defoamer additive.

[0083] The eco-material index is defined as the ratio, in percentage, between the weight of the RBO of the hydraulic oil composition and the weight of the hydraulic oil composition.

[0084] The hydraulic oil composition of the present invention thus has an eco-material index of at least 5%, in particular of at least 50%, more particularly of at least 75%, even more particularly of at least 85%, even more particularly of at least 95%.

[0085] In a second aspect, it is proposed an hydraulic oil composition comprising:

- a base oil comprising more than or equal to 5% by weight, based on the total weight of said hydraulic oil composition, of a Refined Base Oil and less than or equal to 95% by weight of a Conventional Base Oil,
- a viscosity modifier,

characterized in that the content of viscosity modifier in the hydraulic oil composition is less than 8.5 % by weight based on the total weight of said hydraulic oil composition, in particular from 5% to 8%, more particularly from 7.5% to 7.7%.

[0086] The base oil, the Refined Base Oil, the Conventional Base Oil and the viscosity modifier are as defined above in relation to the hydraulic oil composition of the first aspect of the present invention.

[0087] The hydraulic oil composition of this second aspect may also comprise one or more additives.

[0088] The one or more additives may be a passivation additive, a demusilfier additive, an antioxidant additive, an anti-wear additive, a defoamer additive, a calcium-based additive, an anti-corrosion additive, a friction-modifying additive, an extreme-pressure additive, a detergent, a pour point depressant (PPD) additive, a dispersant, or mixtures thereof, in particular an anti-corrosion additive, a passivation additive, a demusilfier additive, an antioxidant additive, an anti-wear additive, a pour point depressant (PPD) additive, a defoamer additive, a calcium based additive or mixtures thereof, more particularly a defoamer additive and a mixture of an anti-corrosion additive, a passivation additive, a demusilfier additive, an antioxidant additive, an anti-wear additive, a calcium based additive, a pour point depressant (PPD) additive.

[0089] The content of the one or more additives may be less than 9% by weight based on the total weight of the hydraulic oil composition of the present invention, in particular from 8.0% to 8.8%, more particularly from 8.5% to 8.7%.

[0090] For example, the hydraulic oil composition of the present invention may comprise:

from 0.8 % to 1% by weight, based on the total weight of the hydraulic oil composition of the present invention, of a mixture of an anti-corrosion additive, a passivation additive, a demusilfier additive, an antioxidant additive, an anti-wear additive, a calcium based additive,
from 7.5% to 8% by weight, based on the total weight of the hydraulic oil composition of the present invention, of a pour point depressant (PPD) additive, and
from 0.01 to 0.05% be weight, based on the total weight of the hydraulic oil composition of the present invention, of a defoamer additive.

[0091] In another aspect, it is proposed the use of one of the hydraulic oil compositions of the present invention for lubricating moving parts of an hydraulic system, in particular of a hydrostatic hydraulic fluid power system, more particularly of an air compressor.

[0092] In another aspect, it is proposed a use of a Refined Base Oil to formulate or manufacture the hydraulic oil composition of the present invention.

[0093] The Refined Base Oil is as defined above in relation to the hydraulic oil composition of the first aspect of the present invention.

[0094] In another aspect, it is proposed a method for manufacturing the hydraulic oil composition of the present invention comprising at least a step of obtaining a Refined Base Oil from a used lubricant composition.

[0095] The Refined Base Oil and the used lubricant composition are as defined above in relation to the first aspect of the present invention.

[0096] In another aspect, it is proposed a method of lubricating an hydraulic system comprising the following step:

a) contacting moving parts of the hydraulic system needing an hydraulic oil composition to be lubricated with the hydraulic oil composition of the present invention.

Examples

Example 1: Composition and lubricant properties

[0097] The composition and lubricant properties of three hydraulic oil compositions have been evaluated. Hydraulic oil compositions 1 and 2 are according to the invention. Comparative hydraulic oil composition is not according to the invention.

[0098] Table 1 presents the properties of the RBO present in Hydraulic oil compositions 1 and 2 and the method used to determine each of said properties.

[0099] Table 2 presents the composition of each of the three hydraulic oil compositions. The percentages are expressed by weight, relative to the total weight of the composition.

[0100] Each of the three different CBO is of group II.

[0101] The mixture of additives comprises an anti-corrosion additive, a passivation additive, a demusilfier additive, an antioxidant additive, an anti-wear additive, a calcium based additive and a pour point depressant (PPD) additive.

[0102] Table 3 presents the properties of each of the three hydraulic oil compositions and the method used to determine each of said properties.

[Table 1]

Properties	**Method**	**RBO 1**	**RBO 2**
kinematic viscosity at 40°C	ASTM D445	32.91 mm^2/s	31.92 mm^2/s
kinematic viscosity at 100°C	ASTM D445	5.869 mm^2/s	5.717 mm^2/s
Viscosity Index	NF ISO 2909	123	121
Molar mass	ASTM D2502	443 g/mol	436 g/mol
Pour point	ASTM D5950	-15°C	-30°C
Sulfur content	ASTM D2226	1009 ppm	33 ppm
Nitrogen content	ASTM 4629	58 ppm	4 ppm

[Table 2]

Components		**Hydraulic oil composition 1**	**Hydraulic oil composition 2**	**Comparative Hydraulic oil composition**
Base oil	RBO 1	91.41 %		
	RBO 2		86.42 %	
	CBO 1: Group II			38.00 %
	CBO 2: Group II			52.425 %
	CBO 3: Group II		5.00 %	
Viscosity Modifier		7.6 %	7.6 %	8.6 %
Additives	Mixture of additives	0.95 %	0.95 %	0.95 %
	Defoamer additive	0.04 %	0.03 %	0.025 %

[0103] As evidenced by Table 3, the three hydraulic oil compositions meet the technical requirements of the ISO specification 11158:2023 HV, *i.e.* :

- a kinematic viscosity at 40°C between 41.4 Cst and 50.6 Cst, and

- a viscosity index higher than 140.

[0104] As further evidenced by Table 3, in comparison to the comparative hydraulic oil composition, the hydraulic oil compositions 1 and 2 of the present invention have:

- improved shear stability. Indeed, the kinematic viscosity loss after 20 hours of KRL Shear of the composition 1 and 2 is at least 34% less than the kinematic viscosity loss after 20 hours of KRL Shear of the comparative composition,

- improved wet filterability. Indeed, the comparative hydraulic oil composition cannot be filtered during the stage II filterability while the composition 1 and 2 can be filtered, and

- improved demulsibility. Indeed, the time necessary to the composition 1 and 2 to release water is at least 37% less than the time necessary to the comparative composition to release water.

[Table 3]

Properties	Method	Hydraulic oil composition 1	Hydraulic oil composition 2	Comparative Hydraulic oil composition
kinematic viscosity at 40°C	ASTM D445	47.35 mm^2/s	48.47 mm^2/s	46.76 mm^2/s
kinematic viscosity at 100°C	ASTM D445	8.743 mm^2/s	8.835 mm^2/s	8.608 mm^2/s
Viscosity Index	ASTM D2270	166	164	164
Kinematic viscosity loss after 20 hours of KRL Shear	CEC-L-45A-99	5.80 %	5.85 %	8.91 %
Stage I filterability	ISO 13357:01	66.54	79.55	30.85
Stage II filterability		10.94	62.42	Unfilterable
Demulsibility	ASTM D1401	4.4 min	4.3 min	7 min

Example 2: Global Warming Potential

[0105] The Global Warming Potential of each of the three composition of Example 1 is measured applying the IPCC 2021 requirements.

[0106] In comparison to the Global Warming Potential of the Comparative Hydraulic oil composition:

- the Global Warming Potential of the Hydraulic oil composition 1 comprising a base oil consisting of RBO is reduced by 50%, and
- the Global Warming Potential of the Hydraulic oil composition 2 comprising a base oil comprising RBO and 5% of CBO is reduced by 40%.

Claims

1. Hydraulic oil composition comprising:

- a base oil comprising more than or equal to 5% or more by weight, based on the total weight of said hydraulic oil composition, of a Refined Base Oil (RBO) and 95% or less by weight of a Conventional Base Oil (CBO),
- a viscosity modifier,

characterized in that the content of viscosity modifier in the hydraulic oil composition is reduced by at least 5%

compared to the content of viscosity modifier needed to be added in a comparative hydraulic oil composition in which all the RBO is replaced by a CBO, to maintain the technical properties of the hydraulic oil composition as requested by ISO specification 11158:2023 HV.

2. Hydraulic oil composition according to claim 1, wherein the technical property requested by ISO specification 11158:2023 HV is a kinematic viscosity at 40°C higher than 46 mm^2/s.

3. Hydraulic oil composition according to any one of claims 1 or 2, wherein the technical property requested by ISO specification 11158:2023 HV is a viscosity index higher than 160.

4. Hydraulic oil composition according to any one of claims 1 to 3, wherein the kinematic viscosity at 40°C of the Refined Base Oil is from 3.0 mm^2/s to 10.0 mm^2/s.

5. Hydraulic oil composition according to any one of claims 1 to 4, wherein the viscosity index of the Refined Base Oil is from 110 to 150.

6. Hydraulic oil composition according to any one of claims 1 to 5, wherein the pour point of the Refined Base Oil is from -40°C to 0°C.

7. Hydraulic oil composition according to any one of claims 1 to 6, wherein the characteristics of Refined Base Oil fulfil the criteria defined by the classification API for the base oil of groups I, II, III, IV and/or V, in particular of groups I, II and/or III, more particularly of groups I and/or II.

8. Hydraulic oil composition according to any one of claims 1 to 7, wherein the CBO is of the group I, II, III, IV and/or V of the classification API.

9. Hydraulic oil composition according to any one of claims 1 to 7, wherein the base oil consists of Refined Base Oil.

10. Hydraulic oil composition according to any one of claims 1 to 9, wherein the content of viscosity modifier is less than 8.5 % by weight based on the total weight of said hydraulic oil composition.

11. Hydraulic oil composition according to any one of claims 1 to 10 further comprising one or more additives being a passivation additive, an antioxidant additive, an anti-wear additive, a defoamer additive, a calcium-based additive, an anti-corrosion additive, a friction-modifying additive, an extreme-pressure additive, a detergent, a pour point depressant (PPD) additive, a dispersant, or mixtures thereof.

12. Hydraulic oil composition according to any one of claims 1 to 11 having an eco-material index of at least 5%, the eco-material index being defined as the ratio, in percentage, between the weight of the Refined Base Oil (RBO) of the hydraulic oil composition and the weight of the hydraulic oil composition.

13. Hydraulic oil composition according to any one of claims 1 to 12 having a Global Warming Potential reduced by at least 10% compared to the Global Warming Potential of the comparative hydraulic oil composition.

14. Use of the hydraulic oil composition as defined in any one claims 1 to 13 for lubricating moving parts of an hydraulic system.

15. A method of lubricating an hydraulic system comprising the following step:

a) contacting moving parts of the hydraulic system needing an hydraulic oil composition to be lubricated with an hydraulic oil composition as defined in any one claims 1 to 13.

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EUROPEAN SEARCH REPORT

Application Number
EP 23 21 8140

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	CN 104 694 233 A (XINJIANG FUKE OIL CO LTD) 10 June 2015 (2015-06-10) * claims 1-2; par. 8-9, 26 * -----	1-15	INV. C10M169/04 ADD. C10N20/02 C10N40/08 C10N20/00 C10N30/02 C10N30/18 C10N30/00
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A	Anonymous: "FIREBIRD AW HYDRAULIC OIL - Phillips 66 Lubricants", , 22 September 2023 (2023-09-22), XP093160302, Retrieved from the Internet: URL:https://web.archive.org/web/20230922181724/https://phillips66lubricants.com/product/firebird-aw-hydraulic-oil/ [retrieved on 2024-05-07] * the whole document * -----	1-15	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	7 May 2024	Greß, Tobias

CATEGORY OF CITED DOCUMENTS

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