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(54) **AQUEOUS LUBRICANT COMPOSITION COMPRISING A GALLIC ACID ESTER**

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(57) **ABSTRACT**

The invention relates to an aqueous lubricant composition comprising at least: —water; —at least one polyalkylene glycol; —at least one antifreeze compound selected from glycols, preferably alkylene glycols; glycerol; diglycerol; triglycerol, and mixtures thereof; —at least one gallic acid ester; and—at least one pH-regulating additive, making it possible to maintain the pH of said lubricant composition between (8) and (15). It also relates to the use of such an aqueous lubricant composition, for lubricating and/or cooling the moving parts in a mechanical system or as a hydraulic fluid. The invention also relates to the use of at least one gallic acid ester as an additive for improving the tribological properties of an aqueous lubricant composition.

AQUEOUS LUBRICANT COMPOSITION COMPRISING A GALLIC ACID ESTER

TECHNICAL FIELD

[0001] The present invention relates to the field of lubricant compositions. These lubricant compositions can be used for various applications, in particular as hydraulic fluids, for lubricating and/or cooling various mechanical systems, such as rolling bearings, gears, bearings or motors.

[0002] More particularly, the present invention is directed toward proposing a novel water-based lubricant composition.

PRIOR ART

[0003] Lubricant compositions, also called "lubricants", are commonly used in mechanical systems for reducing friction between parts and thus protecting the parts against wear. In addition to wear phenomena, friction can oppose the relative movement of parts that are in contact and induce energy losses that are detrimental to the optimum functioning of the mechanical system.

[0004] Lubricants are used in many applications, for example in metalworking, notably for metal deforming operations, for gas or steam turbines in the aeronautical, naval, railway and power generation fields, for motor vehicle propulsion systems, for example for lubricating rolling bearings, gears, engines, etc.

[0005] For example, in the field of lubricants for motor vehicle engines and transmissions, the formulation of lubricants is a major challenge insofar as it enables action to be taken on fuel consumption and, consequently, on carbon dioxide emissions, via their impact on the friction forces generated between the various components of motor vehicles.

[0006] Irrespective of the intended application, the most widespread lubricants are hydrocarbon-based lubricants, conventionally composed of one or more base oils which are generally combined with additives intended for stimulating the lubricant performance of the base oils, for instance friction-modifying additives.

[0007] Moreover, friction between the moving parts generates heat, and it may be necessary, in conjunction with lubrication, to provide for the cooling of mechanical systems or machined parts. This cooling is typically provided by a cooling fluid, different from the hydrocarbon-based lubricant, for instance air, an aqueous fluid, such as water, or a mixture of water and a glycol.

[0008] Nowadays, the development of new lubricants must take into consideration new constraints directed toward dispensing with the use of toxic or potentially toxic solvents, or toward reducing their impact on the environment and carbon dioxide emissions. In this respect, water-based formulations are of growing interest.

[0009] Although water is an excellent cooling fluid, it does not have the tribological properties required for a lubricant, particularly in terms of reducing friction and protecting parts against wear.

[0010] Water-based lubricant compositions, supplemented with various additives, have already been studied. In general, these aqueous lubricants thus consist of an aqueous fraction and an organic fraction.

[0011] For example, US 2012/0149616 proposes an aqueous lubricant comprising, in addition to water, water-soluble polyalkylene glycols, emulsifiers, antifreeze additives of alkylene glycol or glycerol type, anticorrosion additives, antifoaming additives and friction-reducing additives.

[0012] Mention may also be made of EP 3 042 946, which proposes an oil-free and emulsifier-free metalworking fluid comprising a cellulose-type polymer.

[0013] However, the use of the organic compounds proposed to date for aqueous lubricants (polyalkylene glycols, organic surfactants, biocomponents) does not allow sufficient lubricating properties to be achieved under severe conditions (high temperature and/or pressure conditions, severe mechanical contact, high shear, etc.), also known as "limit regime" lubrication conditions (defined, for example, in the book *Manuel des Techniques de l'ingénieur, Introduction à la Tribologie* [*Manual of Engineering Techniques, Introduction to Tribology*], *Part* 2.1, Jean Frêne and Hamid Zaïdi, published on Sep. 10, 2011). These aqueous lubricants are thus liable to lead to the formation of carbon deposits on mechanical parts when used in extreme conditions.

[0014] The use of these aqueous lubricants consequently implies specific running-in conditions and materials or part design, which represents an obstacle to their widespread use as a replacement for conventional hydrocarbon-based lubricants.

[0015] It has also already been proposed to include nanoparticles of solid lubricant (nanodiamond, MoS_2, WS_3, graphite, etc.) suspended in an aqueous fluid in aqueous formulations.

[0016] Unfortunately, the use of these solid particles is not without its problems of stability, lubricant implementation and safety from a toxicological point of view.

[0017] Consequently, the aqueous lubricants proposed to date are unable to compete with hydrocarbon-based lubricants.

[0018] Thus, there remains a need to be able to develop new additivation systems that can give aqueous fluids satisfactory lubrication performance, notably under severe conditions and, at the very least, performance equivalent to that obtained with conventional hydrocarbon-based lubricants.

[0019] For example, patent application WO 2021/1259851 proposes a new water-based lubricant formulation comprising glycerol and hypericin. Mention may also be made of patent application WO 2021/259853, which proposes an aqueous lubricant composition comprising a polyalkylene glycol, an antifreeze compound and a phosphorus compound.

DISCLOSURE OF THE INVENTION

[0020] The present invention is specifically directed toward proposing a novel aqueous lubricant with particularly advantageous tribological properties, in particular good friction reduction and wear resistance properties, allowing it to be used in applications imposing severe lubrication constraints, in particular under conditions of high pressure and shear stress.

[0021] More particularly, according to a first of its aspects, the present invention relates to an aqueous lubricant composition, comprising at least:

[0022] water;

[0023] at least one polyalkylene glycol;

[0024] at least one antifreeze compound chosen from glycols, preferably alkylene glycols;

[0025] glycerol; diglycerol; triglycerol, and mixtures thereof;

[0026] at least one gallic acid ester; and

[0027] at least one pH-regulating additive for maintaining the pH of said lubricant composition between 8 and 15.

[0028] For the purposes of the present invention, the term "aqueous composition" is intended to denote a composition comprising water as the base fluid, in other words as the majority solvent. In particular, water preferably represents more than 35% by mass of the total mass of the lubricant composition.

[0029] In the continuation of the text, the term "aqueous lubricant composition" or "aqueous lubricant" will be used to denote a lubricant composition according to the invention as defined previously.

[0030] Gallic acid is found in its natural state in various plants and is known for its antioxidant, antitumor and antibacterial properties. Moreover, certain gallic acid esters have already been proposed as antioxidant additives in the agrifood field (propyl gallate is known under the antioxidant name "E310") or in plant oils (Lida A. Quinchia et al., Journal of Agricultural and Food Chemistry, 2011, 29, 12917-12924).

[0031] However, to the inventors' knowledge, it has never been proposed to use gallic acid esters in aqueous lubricants, and even less so for the purpose of improving their tribological performance.

[0032] Contrary to all expectation, the inventors have discovered that it is possible, by implementing the specific combination of at least one antifreeze compound chosen from glycols, at least one gallic acid ester and at least one polyalkylene glycol, to access an aqueous formulation which has excellent tribological properties.

[0033] In particular, as illustrated in the following examples, by supplementing an aqueous formulation, containing a mixture of water, at least one polyalkylene glycol, at least one pH-regulating additive which maintains the pH of said formulation between 8 and 15, and at least one glycol-type antifreeze compound, with a gallic acid ester, such as octyl or lauryl gallate, it is possible to obtain a lubricant fluid with improved tribological properties.

[0034] Advantageously, an aqueous lubricant according to the invention thus offers good performance in terms of friction reduction, in particular under severe operating conditions.

[0035] The invention thus relates to the use of at least one gallic acid ester as an additive for improving the tribological properties, in particular in terms of friction reduction, of an aqueous composition further comprising at least: water, at least one polyalkylene glycol, at least one antifreeze compound chosen from glycols, and at least one pH-regulating additive which maintains the pH of said composition between 8 and 15.

[0036] In particular, the aqueous lubricant compositions formulated according to the invention allow such a reduction in wear and friction that they may be considered "superlubricant", i.e. the friction phenomena may be considered insignificant, or even non-existent, even under severe lubrication conditions. This extreme reduction in wear and friction between moving mechanical parts is known as "superlubricity".

[0037] The good tribological properties of the aqueous lubricant compositions according to the invention, similarly under severe lubrication conditions, make them suitable for widespread use. They thus prove to be suitable for use as lubricants in a wide range of applications, notably as hydraulic fluids, for the lubrication and/or cooling of various mechanical systems, in particular under severe lubrication conditions. They can thus be used in all systems and for all applications, as a substitute for the conventional lubricants used, notably hydrocarbon-based lubricants. Application examples are given in the continuation of the text.

[0038] According to another of its aspects, the invention thus relates to the use of an aqueous lubricant composition according to the invention, for the lubrication and/or cooling of moving parts in a mechanical system, for example for the lubrication and/or cooling of mobile or stationary drive systems, or as a hydraulic fluid.

[0039] The present patent application also relates to the use of an aqueous lubricant composition according to the invention for reducing friction between moving parts in a mechanical system, and also to the use of an aqueous lubricant composition according to the invention for reducing the wear of parts in a mechanical system.

[0040] By way of example, an aqueous lubricant according to the invention may be used for reducing the friction and/or wear of moving parts in a mobile or stationary drive system, for example in the transmission part of a vehicle propulsion system.

[0041] An aqueous lubricant according to the invention may also be used in a hydraulic system for reducing the friction and/or wear of various components, notably metal components.

[0042] Advantageously, a composition according to the invention combines good cooling properties linked to the presence of water, and good tribological properties, in particular friction reduction and wear resistance. Thus, an aqueous composition according to the invention can advantageously perform the dual function of lubrication and cooling.

[0043] It is thus possible to take advantage of an aqueous composition according to the invention to dispense with the use of two separate fluids, on the one hand a cooling fluid and on the other hand a lubricant fluid.

[0044] Also, a composition according to the invention has the advantage of being easy to formulate.

[0045] Advantageously, it also has good anticorrosion properties.

[0046] Finally, the gallic acid esters used in a composition according to the invention may advantageously be biobased. The term "biobased" denotes any component of plant or animal origin, preferably of plant origin.

[0047] A lubricant composition according to the invention, formed predominantly of water, and comprising at least one biobased additive, thus meets expectations in terms of reducing the use of substances that are harmful to the environment, while at the same time achieving lubrication performance equivalent to that of conventional oil-based lubricants.

[0048] Finally, an aqueous lubricant composition according to the present invention advantageously has a very good ability to dissolve the various compounds it comprises, in particular said antifreeze compound(s), said gallic acid ester (s) and said polyalkylene glycol(s).

[0049] Other features, variants and advantages of an aqueous lubricant composition according to the invention will emerge more clearly on reading the description and the examples that follow, which are given as nonlimiting illustrations of the invention.

[0050] The terms "between . . . and . . . ", "ranging from . . . to . . . ", "formed from . . . to . . . " and "varying from . . . to . . . " should be understood as being limits inclusive, unless otherwise mentioned.

[0051] In the description and the examples, unless otherwise indicated, the percentages are weight percentages. The percentages are thus expressed on a mass basis relative to the total mass of the composition.

DETAILED DESCRIPTION

Aqueous Composition

[0052] As mentioned previously, an aqueous lubricant composition according to the invention, also called an aqueous lubricant, is a formulation comprising water as the majority solvent.

[0053] For the purposes of the invention, the term "majority solvent" means that water is present in greater amount than any other solvent that may be present in the composition. Preferably, an aqueous lubricant composition according to the invention comprises at least 20% by mass of water, in particular of deionized water, preferably at least 30% by mass, notably between 35% and 90% by mass, more preferentially between 40% and 75% by mass, relative to the total mass of the composition.

[0054] By acting as a solvent, water enables the polyalkylene glycol(s), the glycol-type antifreeze compound(s) and the gallic acid ester(s) to be dissolved at the desired pH of said composition, along with any additives that may be present in the composition, in particular chosen from those detailed in the text hereinbelow.

[0055] Advantageously, in addition to its role as a solvent, water affords access to a lubricant composition with good cooling properties, which can be used as a cooling fluid for moving parts in a mechanical system.

[0056] According to a particular embodiment, the water used in an aqueous lubricant composition according to the invention is osmosed or demineralized water, more preferentially deionized water.

[0057] For the purposes of the present invention, the term "osmosed water" is intended to denote water which has undergone a purification, notably via a reverse osmosis process, so as to reduce the content of organic and/or mineral compounds, for example to a content of less than 5.0% by weight, preferably less than 1.0% by weight. In the continuation of the text, the terms "demineralized water" or "ultrapure water" will be considered to be equivalent to or synonymous with the term "osmosed water". In particular, osmosed water may be "deionized water", in other words water which has undergone a purification so as to reduce the content of ions such as the Ca^{2+} and HCO_3^- ions generally present in water. Preferably, a deionized water does not comprise any ions.

[0058] The use of deionized water is thus particularly advantageous in the context of the use of the aqueous lubricant according to the invention for applications requiring a fluid which conducts little or no electricity, for instance for the use of the aqueous lubricant for the lubrication and cooling of mechanical systems comprising an electrical circuit, for example electric or hybrid motors, in particular in electric or hybrid vehicles.

[0059] An aqueous lubricant composition according to the invention thus differs from lubricants conventionally used in mechanical systems, which comprise a majority proportion of one or more water-insoluble base oils.

[0060] The term "water-insoluble oil" notably means an oil which does not substantially dissolve in water at room temperature (at about 25° C.). In particular, a water-insoluble oil has a solubility in water of less than 0.2 g/L at room temperature.

[0061] This notably concerns lubricant base oils belonging to groups I to V according to the classes defined in the API classification (or their equivalents according to the ATIEL classification) and mixtures thereof.

[0062] Preferably, an aqueous lubricant composition according to the present invention comprises less than 5% by mass, preferably less than 2% by mass, more preferentially less than 1% by mass of water-insoluble oil(s), relative to the total mass of the composition.

[0063] Advantageously, an aqueous lubricant composition according to the invention is totally free of water-insoluble oil.

Polyalkylene Glycol

[0064] As indicated previously, an aqueous lubricant composition according to the invention comprises at least one polyalkylene glycol.

[0065] The polyalkylene glycols (noted "PAG") are chosen from water-soluble polyalkylene glycols.

[0066] The term "water soluble" is intended to denote a polyalkylene glycol with a solubility in water of at least 10 g/L, preferably at least 500 g/L, in water at room temperature (about 25° C.).

[0067] The polyalkylene glycols may be more particularly formed of C_1-C_4, preferably C_1-C_3, more particularly C_2-C_3 alkylene oxide units.

[0068] Advantageously, a polyalkylene glycol used in an aqueous lubricant composition according to the invention comprises at least 50% by mass, in particular at least 80% by mass, more preferentially at least 90% by mass of propylene oxide and/or ethylene oxide units. It may be an optionally statistical ethylene oxide/propylene oxide copolymer.

[0069] Preferably, a polyalkylene glycol used in an aqueous lubricant composition according to the invention has a weight-average molecular mass (Mw) of between 100 and 50 000 $g \cdot mol^{-1}$, preferably between 5000 and 25 000 $g \cdot mol^{-1}$.

[0070] The weight-average molecular mass can be measured by gel permeation chromatography (GPC).

[0071] Preferably, a polyalkylene glycol used in an aqueous lubricant composition according to the invention has a kinematic viscosity measured at 100° C. (KV100), according to the standard ASTM D445, of between 100 and 25 000 mm^2/s, in particular between 150 and 10 000 mm^2/s.

[0072] Preferably, a polyalkylene glycol used in an aqueous lubricant composition according to the invention has a kinematic viscosity measured at 40° C. (KV40), according to the standard ASTM D445, of between 500 and 100 000 mm^2/s, more particularly between 1000 and 95 000 mm^2/s.

[0073] The flash point of a polyalkylene glycol used in an aqueous lubricant composition according to the invention is preferably greater than or equal to 160° C., in particular greater than or equal to 220° C. The flash point can be measured by means of the standard ISO 2592 or ASTM D92.

[0074] Preferably, a polyalkylene glycol used in an aqueous lubricant composition according to the invention has a

viscosity index, measured according to the standard ASTM D2270, of between 100 and 800, preferably between 250 and 550.

[0075] In particular, said polyalkylene glycol compound (s) may be used in an aqueous lubricant composition according to the invention in a content of at least 5.0% by mass, preferably between 5.0% and 50% by mass, more preferentially between 10% and 40% by mass, in particular between 10% and 20% by mass, relative to the total mass of the composition.

[0076] It is understood that an aqueous lubricant composition according to the invention may comprise a single polyalkylene glycol, or a mixture of several different polyalkylene glycols. In particular, an aqueous lubricant composition according to the invention may comprise a mixture of at least two different polyalkylene glycols, more particularly at least one polyalkylene glycol of low weight-average molecular mass and at least one polyalkylene glycol of high weight-average molecular mass.

[0077] It falls within the general competence of a person skilled in the art to adjust the nature and content of polyalkylene glycols of low and high weight-average molecular mass in the polyalkylene glycol mixture, notably with regard to the desired viscosity of the final lubricant composition.

[0078] The combination of at least one polyalkylene glycol of low weight-average molecular mass and at least one polyalkylene glycol of high weight-average molecular mass is most particularly advantageous so as to obtain good dissolution of the various compounds introduced into the aqueous lubricant composition.

Antifreeze Compound

[0079] As indicated previously, an aqueous lubricant composition according to the invention comprises at least one antifreeze compound chosen from glycols, preferably alkylene glycols; glycerol; diglycerol; triglycerol, and mixtures thereof.

[0080] These compounds are known for their antifreeze action, in other words for reducing the freezing point of the composition.

[0081] The glycols are diols in which the two hydroxyl groups are borne by different carbon atoms, preferably by vicinal carbon atoms.

[0082] Preferably, the glycols are alkylene glycols, in particular containing from 2 to 10 carbon atoms, in particular from 2 to 6 carbon atoms. Examples that may be mentioned include monoethylene glycol, diethylene glycol and propylene glycol.

[0083] The antifreeze compound may be chosen from glycerol, diglycerol, triglycerol and mixtures thereof.

[0084] Preferably, the antifreeze compound used according to the invention is chosen from monoethylene glycol, diethylene glycol, propylene glycol, glycerol and mixtures thereof.

[0085] Preferably, the antifreeze compound is diethylene glycol.

[0086] In particular, said antifreeze compound(s) may be used in an aqueous lubricant composition according to the invention in a content of at least 5.0% by mass, preferably between 5.0% and 45% by mass, more preferentially between 10% and 35% by mass, in particular between 20% and 35% by mass, relative to the total mass of the composition.

Gallic Acid Ester

[0087] An aqueous lubricant composition according to the invention comprises at least one gallic acid ester.

[0088] Said gallic acid ester(s) are advantageously used in a water-soluble or emulsifiable form, in particular in the form of ionic salts.

[0089] It is understood that a lubricant composition according to the invention may comprise a single gallic acid ester or a mixture of at least two different gallic acid esters.

[0090] For the purposes of the invention, a gallic acid ester means an ester formed between gallic acid and at least one alcohol.

[0091] A gallic acid ester may comprise several ester functions resulting from the reaction of the carboxylic acid function of gallic acid and of several hydroxyl functions of a polyol.

[0092] A gallic acid ester may thus be a monoester or polyester, notably a gallic acid diester or triester.

[0093] In particular, a gallic acid ester may be formed between gallic acid and at least one monoalcohol or a polyol, for example a monoalcohol or a diol.

[0094] For the purposes of the invention, the term "monoalcohol" is intended to denote a compound formed of a hydrocarbon-based chain, of alkyl or alkenyl type bearing a single alcohol function, in contrast to a "polyol" comprising at least two alcohol functions.

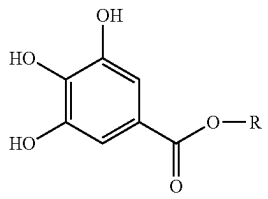
[0095] Preferably, this may be an ester formed between gallic acid and one or more monoalcohols.

[0096] Said monoalcohol(s), which may be identical or different, preferably comprise between 1 and 24 carbon atoms, preferably between 3 and 20 carbon atoms, notably between 3 and 18 carbon atoms, more preferentially between 6 and 16 carbon atoms, for example between 8 and 14 carbon atoms.

[0097] Said monoalcohol(s) are preferably linear, in particular saturated, monoalcohols.

[0098] A gallic acid ester that is suitable for use in the present invention may more particularly correspond to formula (I) below:

(I)



in which R represents a linear or branched, saturated, mono- or polyunsaturated hydrocarbon-based chain, preferably a linear and saturated, C_1-C_{24}, preferably C_3-C_{20}, more preferentially C_3-C_{18}, notably C_6-C_{16}, for example C_8-C_{14}, hydrocarbon-based chain.

[0099] In a particular embodiment, a gallic acid ester according to the invention is obtained from gallic acid and a monoalcohol chosen from 1-propanol, 1-butanol, 1-octanol and 1-dodecanol, in particular chosen from 1-octanol and 1-dodecanol.

[0100] Advantageously, a gallic acid ester according to the invention is chosen from octyl gallate, lauryl gallate and mixtures thereof.

[0101] According to a particular embodiment, an aqueous lubricant composition according to the invention comprises, as gallic acid ester(s), at least lauryl gallate.

[0102] According to a particular embodiment, an aqueous lubricant composition according to the invention comprises, as gallic acid ester(s), at least octyl gallate.

[0103] In a particular embodiment, an aqueous lubricant composition according to the invention may include a single gallic acid ester, in particular lauryl gallate or octyl gallate, preferably lauryl gallate.

[0104] The gallic acid ester(s) used according to the invention may be commercially available or prepared according to synthetic methods known to those skilled in the art. These synthetic methods more particularly include an esterification reaction between at least one hydroxyl function of an alcohol and the carboxylic acid function of gallic acid.

[0105] The gallic acid ester(s) may be advantageously biobased, i.e. they may be obtained from biomass.

[0106] An aqueous lubricant composition according to the invention may comprise between 0.001% and 10% by mass of gallic acid ester(s), in particular as defined above, preferably between 0.01% and 5% by mass, more preferentially between 0.1% and 2% by mass, relative to the total mass of the composition.

pH-Regulating Additive

[0107] An aqueous lubricant composition according to the invention may comprise at least one pH-regulating additive, more particularly an "alkaline buffer", for maintaining the alkaline pH of the lubricant composition.

[0108] More particularly, said pH-regulating additive(s) allow the pH of said lubricant composition to be maintained between 8 and 15.

[0109] By maintaining the pH of the aqueous lubricant composition between 8 and 15, said pH regulator(s) notably prevent the corrosion of metal surfaces, but also promote the dissolution of the various compounds in the lubricant composition, in particular the polyalkylene glycol(s), the antifreeze compound(s) and the gallic acid ester(s), in particular as defined previously.

[0110] Advantageously, the pH-regulating additive(s) allow the pH of the aqueous lubricant composition to be maintained between 8.5 and 14, more particularly between 9 and 13, or for example between 8 and 11.

[0111] In particular, the pH-regulating additive(s) are chosen from amines, more particularly from alkanolamines and amino alcohols. pH-regulating additives that may be mentioned include alkanolamines, such as dimethylethanolamine (DMEA), ethanolamines, such as monoethanolamine (MEA), diethanolamine (DEA), triethanolamine (TEA), isopropanolamines, such as monoisopropanolamine (MIPA), diisopropanolamine (DIPA) and triisopropanolamine (TIPA); diglycolamine (DGA); ethylene amines, such as ethylenediamine (EDA), diethylenetriamine (DETA), triethylenetetramine (TETA) and tetraethylenepentamine (TEPA), cyclamines, such as cyclohexylamine, 2-amino-2-ethyl-1,3-propanediol, 2-amino-2-methyl-1-propanol and mixtures thereof.

[0112] Preferably, the pH-regulating additive(s) are chosen from alkanolamines, in particular ethanolamines, and more particularly from dimethylethanolamine (DMEA), triethanolamine (TEA) and mixtures thereof, and more particularly dimethylethanolamine.

[0113] It is understood that the composition may comprise one or more pH-regulating additives allowing the desired pH of the aqueous lubricant composition to be maintained.

[0114] According to a particular embodiment, an aqueous lubricant composition according to the invention comprises at least one alkanolamine, in particular dimethylethanolamine (DMEA) and/or triethanolamine (TEA), as pH-regulating additive.

[0115] According to another embodiment, an aqueous lubricant composition according to the invention comprises an ethanolamine, in particular triethanolamine (TEA), as pH-regulating additive.

[0116] An aqueous lubricant composition according to the invention may notably comprise from 0.1% to 10% by mass of pH-regulating additive(s) for maintaining the pH of the lubricant composition between 8 and 15, in particular as defined previously, notably chosen from alkanolamines, preferably from 0.5% to 5% by mass, relative to the total mass of the composition.

[0117] An aqueous lubricant composition according to the invention may optionally comprise, in addition to at least one pH-regulating additive for maintaining the pH of the lubricant composition between 8 and 15, in particular as defined above, one or more different pH-regulating additive(s), referred to as "auxiliary pH-regulating additive(s)".

[0118] In this case, it is understood that the nature and content of the auxiliary pH-regulating additive(s) are chosen so as not to affect the overall pH of the aqueous lubricant composition, maintained between 8 and 15 by the presence of said pH-regulating additive(s) as described previously.

[0119] According to a particular embodiment, an aqueous lubricant composition according to the invention may comprise at least:

- **[0120]** at least 35% by mass of water, in particular deionized water;
- **[0121]** from 5.0% to 50% by mass of at least one polyalkylene glycol, in particular as defined previously;
- **[0122]** from 5.0% to 35% of at least one antifreeze compound chosen from glycols, preferably alkylene glycols; glycerol; diglycerol; triglycerol, and mixtures thereof; preferably diethylene glycol;
- **[0123]** from 0.001% to 10% by mass of at least one gallic acid ester, in particular as described above, notably lauryl gallate; and
- **[0124]** from 0.1% to 10% by mass of at least one pH-regulating additive for maintaining the pH of the lubricant composition between 8 and 15, in particular as defined previously, notably chosen from alkanolamines.

Other Additives

[0125] An aqueous lubricant composition according to the invention may further comprise various other additives.

[0126] It is understood that said additive(s) are compatible with their use in an aqueous medium.

[0127] Advantageously, the additives are used in a water-soluble or water-emulsifiable form, for example in the form of salts or ionic liquids.

[0128] Needless to say, said additive(s) are chosen with regard to the intended application of the aqueous lubricant.

[0129] Needless to say, a person skilled in the art will take care to choose any additives and/or the amount thereof such that the advantageous properties of the aqueous lubricant composition according to the invention, in particular the

tribological properties, notably in terms of reducing friction and protecting parts against wear, and of cooling, are not adversely affected by the envisaged addition.

[0130] Such additives may be chosen more particularly from antifoaming agents, biocides, corrosion inhibitors, antiwear and/or extreme-pressure additives, sequestrants, metal passivating agents, dyes, dispersants, emulsifying agents, and mixtures thereof.

[0131] Advantageously, an aqueous lubricant composition according to the invention may comprise one or more additives chosen from antifoaming agents, corrosion inhibitors, metal passivating agents, dyes, and mixtures thereof.

[0132] An aqueous lubricant composition according to the invention may more particularly comprise from 0.1% to 10% by mass of additives, in particular from 1.0% to 8.0% by mass of additives, relative to the total mass of the composition.

Corrosion Inhibitor

[0133] An aqueous lubricant composition according to the invention may comprise at least one corrosion inhibitor. Corrosion inhibitors advantageously make it possible to reduce or even prevent the corrosion of metal parts. The nature of said corrosion inhibitor(s) can be chosen with regard to the metal to be protected against corrosion, such as aluminum, steel, galvanized steel, or yellow metals, for example copper or brass.

[0134] Among the inorganic corrosion inhibitors that may be mentioned are sodium, potassium, calcium or magnesium nitrites, sulfites, silicates, borates or phosphates, alkali metal phosphates, and zinc, magnesium or nickel hydroxides, molybdates or sulfates.

[0135] Among the organic corrosion inhibitors, mention may be made of alkanolamines, such as triethanolamine, aliphatic monocarboxylic acids, in particular containing from 4 to 15 carbon atoms, for example octanoic acid, aliphatic dicarboxylic acids containing from 4 to 15 carbon atoms, for example decanedioic acid, undecanedioic acid, dodecanedioic acid or mixtures thereof, polycarboxylic acids optionally neutralized with triethanolamine, such as 1,3,5-triazine-2,4,6-tris(6-aminocaproic acid), alkanoylamidocarboxylic acids, in particular isononanoylamidocaproic acid, and mixtures thereof. Borate-based amides, produced by the reaction of amines or amino alcohols with boric acid, may also be used.

[0136] Preferably, the corrosion inhibitor(s) are different from the pH-regulating additive(s) for maintaining the pH of the lubricant composition between 8 and 15, and defined previously.

[0137] An aqueous lubricant composition according to the invention may notably comprise from 0.1% to 5% by mass of corrosion inhibitor(s), preferably from 0.5% to 4% by mass, more preferentially from 1% to 2.5% by mass, relative to the total mass of the composition.

[0138] In a particular embodiment, an aqueous lubricant composition according to the invention comprises at least:

[0139] water;

[0140] at least one polyalkylene glycol;

[0141] at least one antifreeze compound chosen from glycols, preferably alkylene glycols;

[0142] glycerol; diglycerol; triglycerol, and mixtures thereof;

[0143] at least one gallic acid ester, in particular as defined previously;

[0144] at least one pH-regulating additive for maintaining the pH of the lubricant composition between 8 and 15, in particular as defined previously, notably chosen from alkanolamines; and

[0145] at least one corrosion inhibitor, in particular at least one organic corrosion inhibitor, more particularly chosen from aliphatic monocarboxylic acids.

Antiwear/Extreme-Pressure Additive

[0146] An aqueous lubricant composition according to the invention may comprise at least one antiwear and/or extreme-pressure additive. Their function is to reduce wear and the coefficient of friction, or to prevent metal-to-metal contact by forming a protective film adsorbed onto these surfaces.

[0147] A wide variety of antiwear additives exists, among which mention may be made of those chosen from phosphosulfur additives such as metal alkylthiophosphates or salts thereof.

[0148] Additives which do not supply any phosphorus may also be suitable for use, for instance polysulfides, notably sulfur-based olefins.

[0149] According to a particular embodiment, an aqueous lubricant composition according to the invention comprises at least one extreme-pressure additive chosen from sulfur-based fatty acids and dimercaptothiadiazoles, preferably used in their neutralized, emulsifiable or water-soluble form. Advantageously, an aqueous lubricant composition according to the invention comprises at least one extreme-pressure additive of the sulfur-based fatty acid type, preferably in neutralized form, in particular with inorganic basifying agents or alkanolamines.

[0150] The sulfur-based fatty acids may comprise from 8 to 22 carbon atoms and preferably from 12 to 18 carbon atoms.

[0151] The amount of sulfur according to the standard ASTM D2622 provided by said sulfur-based fatty acid(s) may be between 5% and 30% by mass, in particular between 10% and 20% by mass.

[0152] Preferably, the amount of active sulfur at 150° C. according to the standard ASTM D 1662 provided by said sulfur-based fatty acid(s) in the aqueous lubricant composition according to the invention is greater than or equal to 2% by mass, in particular between 5% and 10% by mass, relative to the total mass of the lubricant composition.

[0153] For the purposes of the present invention the term "active sulfur" means the sulfur that a chemical compound is capable of yielding or releasing when this compound is placed under the conditions of the standard ASTM D1662. The standard ASTM D-1662 defines an active sulfur content of a compound at a given temperature as a difference expressed as the weight percentage of sulfur content before and after reaction of a sample of this sulfur-based compound with a given amount of copper for a fixed time.

[0154] The amount of active sulfur at 150° C. (standard ASTM D1662) in the aqueous lubricant composition of the invention may influence its extreme-pressure performance. This amount of active sulfur at 150° C. (ASTM D1662) in the lubricant composition must not be too low, otherwise satisfactory extreme-pressure behavior cannot be obtained. It must not be too high, to avoid the risk of corrosion, notably with respect to metals and metal alloys, notably copper.

[0155] As mentioned previously, said sulfur-based fatty acid(s) are preferably used in an aqueous lubricant composition according to the invention in their form neutralized with a basifying agent, such as sodium hydroxide, potassium hydroxide, or an alkanolamine, such as monoethanolamine, triethanolamine, monoisopropanolamine, diisopropanolamine and triisopropanolamine.

[0156] An aqueous lubricant composition according to the invention may comprise between 0.01% and 10% by mass of antiwear and/or extreme-pressure additive(s), in particular of sulfur-based fatty acid(s), as defined above, preferably between 0.2% and 5% by mass, relative to the total mass of the composition.

Antifoaming Agent

[0157] An aqueous lubricant composition according to the invention may comprise at least one antifoaming additive. Antifoaming agents make it possible to prevent foaming of the lubricant fluid.

[0158] This may be, for example, an antifoaming agent based on polysiloxanes or acrylate polymers. Preferably, the antifoaming agent is chosen from three-dimensional siloxanes.

[0159] Also, the antifoaming agents may be polar polymers such as polymethylsiloxanes or polyacrylates.

[0160] In particular, an aqueous lubricant composition according to the invention may comprise from 0.001% to 3.0% by mass of antifoaming additive(s), preferably from 0.005% to 1.5% by mass, more preferentially from 0.01% to 1.05% by mass, relative to the total mass of the lubricant composition.

[0161] In a particular embodiment, an aqueous lubricant composition according to the invention comprises at least:

[0162] water;

[0163] at least one polyalkylene glycol;

[0164] at least one antifreeze compound chosen from glycols, preferably alkylene glycols;

[0165] glycerol; diglycerol; triglycerol, and mixtures thereof;

[0166] at least one gallic acid ester, in particular as defined previously;

[0167] at least one pH-regulating additive for maintaining the pH of the lubricant composition between 8 and 15, in particular as defined previously, notably chosen from alkanolamines; and

[0168] at least one antifoaming additive, in particular chosen from three-dimensional siloxanes.

Metal Passivating Agents

[0169] An aqueous lubricant composition according to the invention may comprise at least one metal passivating agent. Metal passivating agents make it possible to protect metal parts by promoting the formation of metal oxide on their surface.

[0170] The metal passivating agents may be chosen, for example, from triazole derivatives, such as tetrahydrobenzotriazole (THBTZ), tolyltriazole (TTZ), benzotriazole (BTZ), amines substituted with a triazole group, such as N,N-bis(2-ethylhexyl)-1,2,4-triazol-1-ylmethanamine, N'-bis(2-ethylhexyl)-4-methyl-1H-benzotriazol-1-methylamine, N,N-bis(heptyl)-ar-methyl-1H-benzotriazole-1-methanamine, N,N-bis(nonyl)-ar-methyl-1H-benzotriazole-1-methanamine, N,N-bis(decyl)-ar-methyl-1H-benzotriazole-1-methanamine, N,N-bis(undecyl)-ar-methyl-1H-benzotriazole-1-methanamine, N,N-bis(dodecyl)-ar-methyl-1H-benzotriazole-1-methanamine N,N-bis(2-ethylhexyl)-ar-methyl-1H-benzotriazole-1-methanamine, 1,2,4-triazoles, benzimidazoles, 2-alkyldithiobenzimidazoles, 2-alkyldithiobenzothiazoles, 2-(N,N-dialkyldithiocarbamoyl)benzothiazoles, 2,5-bis(alkyldithio)-1,3,4-thiadiazoles, such as 2,5-bis(tert-octyldithio)-1,3,4-thiadiazole, 2,5-bis(tert-nonyldithio)-1,3,4-thiadiazole, 2,5-bis(tert-decyldithio)-1,3,4-thiadiazole, 2,5-bis(tert-undecyldithio)-1,3,4-thiadiazole, 2,5-bis(tert-dodecyldithio)-1,3,4-thiadiazole, 2,5-bis(tert-tridecyldithio)-1,3,4-thiadiazole, 2,5-bis(tert-tetradecyldithio)-1,3,4-thiadiazole, 2,5-bis(tert-pentadecyldithio)-1,3,4-thiadiazole, 2,5-bis(tert-hexadecyldithio)-1,3,4-thiadiazole, 2,5-bis(tert-heptadecyldithio)-1,3,4-thiadiazole, 2,5-bis(tert-octadecyldithio)-1,3,4-thiadiazole, 2,5-bis(tert-nonadecyldithio)-1,3,4-thiadiazole, 2,5-bis(tert-eicosyldithio)-1,3,4-thiadiazole, 2,5-bis(N,N-dialkyldithiocarbamoyl)-1,3,4-thiadiazoles, 2-alkyldithio-5-mercaptothiadiazoles, and mixtures thereof.

[0171] Preferably, the metal passivating agents are chosen from tetrahydrobenzotriazole (THBTZ), tolyltriazole (TTZ), benzotriazole (BTZ), and salts thereof, taken alone or as mixtures.

[0172] An aqueous lubricant composition according to the invention may notably comprise from 0.01% to 2.0% by mass of metal passivating agent(s), preferably from 0.1% to 1.0% by mass, more preferentially from 0.2% to 0.8% by mass, relative to the total mass of the composition.

[0173] In a particular embodiment, an aqueous lubricant composition according to the invention comprises at least:

[0174] water;

[0175] at least one polyalkylene glycol;

[0176] at least one antifreeze compound chosen from glycols, preferably alkylene glycols;

[0177] glycerol; diglycerol; triglycerol, and mixtures thereof;

[0178] at least one gallic acid ester, in particular as defined previously;

[0179] at least one pH-regulating additive for maintaining the pH of the lubricant composition between 8 and 15, in particular as defined previously, notably chosen from alkanolamines; and

[0180] at least one metal-passivating agent, in particular chosen from triazole derivatives, more particularly chosen from tetrahydrobenzotriazole, tolyltriazole, benzotriazole, and salts thereof, taken alone or as mixtures.

Dyes

[0181] An aqueous lubricant composition according to the invention may comprise one or more dyes. The dyes may be natural or synthetic, generally organic.

[0182] The dyes that may be used in an aqueous lubricant composition may be chosen more particularly from natural or synthetic water-soluble dyes, for example the dyes FDC Red 4, DC Red 6, DC Red 22, DC Red 28, DC Red 30, DC Red 33, DC Orange 4, DC Yellow 5, DC Yellow 6, DC Yellow 8, FDC Green 3, DC Green 5, FDC Blue 1, betanine (beetroot), carmine, a chlorophylline, methylene blue, anthocyans (enocianin, black carrot and hibiscus), xanthenes, caramel and riboflavin.

[0183] An aqueous lubricant composition according to the invention may comprise between 0.01% and 2.0% by mass

of dye(s), preferably between 0.01% and 1.5% by mass, more preferentially between 0.02% and 1.0% by mass, relative to the total mass of the composition.

[0184] In a particular embodiment, an aqueous lubricant composition according to the invention comprises at least:

[0185] water;

[0186] at least one polyalkylene glycol;

[0187] at least one antifreeze compound chosen from glycols, preferably alkylene glycols; glycerol; diglycerol; triglycerol, and mixtures thereof;

[0188] at least one gallic acid ester, in particular as defined previously;

[0189] at least one pH-regulating additive for maintaining the pH of the lubricant composition between 8 and 15, in particular as defined previously, notably chosen from alkanolamines; and

[0190] at least one dye, in particular chosen from xanthenes.

Emulsifying Agents

[0191] An aqueous lubricant composition according to the invention may comprise one or more emulsifying agents, also called emulgators. Their function is to generate stable emulsions in water.

[0192] The emulsifying agents may more particularly be nonionic, for instance ethoxylated fatty alcohols, ethoxylated fatty acids, ethoxylated fatty amides; anionic, for example KOH or NaOH soaps; sulfonates; cationic, such as quaternary ammonium compounds; or water-soluble or water-emulsifiable carboxylic acid esters.

[0193] In particular, an aqueous lubricant composition according to the invention may comprise from 0.01% to 10% by mass of emulsifying agent(s), preferably from 0.1% to 5.0% by mass, relative to the total mass of the lubricant composition.

Sequestrants

[0194] An aqueous lubricant composition according to the invention may comprise at least one sequestrant. Sequestrants, also called chelating agents, make it possible to limit the incrustation of metal ions into the composition.

[0195] As examples of sequestrants, mention may be made of phosphonic acid and phosphonate derivatives, such as diethylenetriaminepentamethylenephosphonic acid (DTPMPA), aminotri(methylenephosphonic acid) (ATMP), hydroxyethanediphosphonic acid (HEDP), 1-hydroxyethylidene 1,1-diphosphonate, 2-hydroxyethylaminebis(methylenephosphonic acid) (HEAMBP), diethylenetriaminepenta (methylenephosphonic acid) (DTMP), multifunctional organic acids and hydroxylated acids, such as ethylenediaminetetraacetic acid (EDTA), pteroyl-L-glutamic acid (PGLU), organic polyacids, such as maleic acid and polyaspartic acid, polysaccharides and carbohydrates, such as inulin, carboxymethylinulin and carboxymethylchitosan.

[0196] An aqueous lubricant composition according to the invention may comprise from 0.001% to 2.0% by mass of sequestrant(s), preferably from 0.01% to 1.0% by mass, relative to the total mass of the composition.

Biocides and Fungicides

[0197] An aqueous lubricant composition according to the invention may comprise at least one biocidal and/or fungicidal agent. The biocides and fungicides may be used to improve the biological stability of the composition by limiting the growth of bacteria, fungi and yeasts in the lubricant fluid.

[0198] Such biocides may be chosen from parabens, aldehydes, reactive acetylacetone compounds, isothiazolinones, phenolic compounds, acid salts, halogenated compounds, quaternary ammoniums, certain alcohols and mixtures thereof.

[0199] Preferably, the biocides may be chosen from optionally substituted benzisothiazolinones (BIT), such as N-butyl-1,2-benzisothiazolin-3-one, methylisothiazolinones (MIT), mixtures of methylisothiazolinone and chloromethylisothiazolinone (MIT/CMIT), ortho-phenylphenol (OPP) or its sodium salt, 3-iodo-2-propynylbutyl carbamate (IPBC), chlorocresol and N,N-methylenebismorpholine (MBM); sorbic acid; preferably from ortho-phenylphenol (OPP) or its sodium salt, 3-iodo-2-propynylbutyl carbamate, chlorocresol, benzisothiazolinones and N,N-methyleneisomorpholine.

[0200] An aqueous lubricant composition according to the invention may notably comprise between 0.01% and 10% by mass of biocide(s) and/or fungicide(s), preferably between 0.5% and 5.0% by mass, relative to the total mass of the composition.

[0201] According to a particular embodiment, an aqueous lubricant composition according to the invention comprises at least:

[0202] water, in particular deionized water;

[0203] at least one polyalkylene glycol, in particular as defined previously;

[0204] at least one antifreeze compound chosen from glycols, preferably alkylene glycols;

[0205] glycerol; diglycerol; triglycerol, and mixtures thereof; preferably diethylene glycol;

[0206] at least one gallic acid ester, in particular as described above, notably lauryl gallate;

[0207] at least one pH-regulating additive for maintaining the pH of the lubricant composition between 8 and 15, in particular as defined previously, notably chosen from alkanolamines; and

[0208] one or more other additives chosen from antifoaming agents, corrosion inhibitors, metal passivating agents and dyes, in particular as defined above.

[0209] In particular, an aqueous lubricant composition according to the invention may comprise:

[0210] at least 35% by mass of water, in particular deionized water;

[0211] from 5.0% to 50% by mass of at least one polyalkylene glycol, in particular as defined previously;

[0212] from 5.0% to 35% of at least one antifreeze compound chosen from glycols, preferably alkylene glycols; glycerol; diglycerol; triglycerol, and mixtures thereof; preferably diethylene glycol;

[0213] from 0.001% to 10% by mass of at least one gallic acid ester, in particular as described above, notably lauryl gallate;

[0214] from 0.1% to 10% by mass of at least one pH-regulating additive for maintaining the pH of the lubricant composition between 8 and 15, in particular as defined previously, notably chosen from alkanolamines; and

[0215] optionally from 0.1% to 10% by mass of one or more other additives chosen from antifoaming agents,

corrosion inhibitors, metal passivating agents and dyes, in particular as defined above.

[0216] More particularly, an aqueous lubricant composition according to the invention may consist of:

[0217] from 5.0% to 50% by mass of at least one polyalkylene glycol, in particular as defined previously;

[0218] from 5.0% to 35% of at least one antifreeze compound chosen from glycols, preferably alkylene glycols; glycerol; diglycerol; triglycerol, and mixtures thereof; preferably diethylene glycol;

[0219] from 0.01% to 5% by mass of at least one gallic acid ester, in particular as described above, notably lauryl gallate;

[0220] from 0.1% to 10% by mass of at least one pH-regulating additive for maintaining the pH of the lubricant composition between 8 and 15, in particular as defined previously, notably chosen from alkanolamines; and

[0221] optionally from 0.1% to 10% by mass of one or more other additives chosen from antifoaming agents, corrosion inhibitors, metal passivating agents and dyes, in particular as defined above;

[0222] the contents being expressed relative to the total mass of the lubricant composition,

[0223] the remainder being water, in particular deionized water.

[0224] It is understood that the various particular embodiments described previously may be combined, as far as is possible, to define other particular embodiments.

[0225] In particular, each of the additives specifically described above may be introduced alone, or in combination with at least one other of the additives specifically described, thus defining different embodiment variants of an aqueous lubricant composition according to the invention.

[0226] In other words, particular embodiments of the invention are defined by an aqueous lubricant composition according to the invention, comprising at least water, one or more polyalkylene glycols; one or more antifreeze compounds, one or more gallic acid esters, in particular as defined previously, one or more pH-regulating additives in particular as defined previously, preferably in the proportions indicated above, and also comprising one or more of the other additives specifically detailed in the text.

[0227] Advantageously, a lubricant composition according to the invention has a kinematic viscosity, measured at 40° C. (KV40), according to the standard ASTM D445 (ISO 3104), of between 10 and 1000 mm^2/s, in particular between 20 and 300 mm^2/s, more particularly between 25 and 80 mm^2/s.

[0228] The kinematic viscosity, measured at 100° C. (KV100), according to the standard ASTM D445 (ISO 3104), of a lubricant composition according to the invention may advantageously be between 3 and 50 mm^2/s, in particular between 4 and 25 mm^2/s and more particularly between 5 and 10 mm^2/s.

[0229] Advantageously, a lubricant composition according to the invention has a kinematic viscosity, measured at −10° C. (KV-10), according to the standard ASTM D445 (ISO 3104), of between 200 and 600 mm^2/s, in particular between 250 and 500 mm^2/s, more particularly between 275 and 400 mm^2/s.

Application

[0230] As mentioned previously, an aqueous lubricant composition formulated according to the invention, in particular as described previously, has excellent tribological properties, notably in terms of friction reduction and wear resistance, which makes it particularly suitable for use as a lubricant fluid.

[0231] Aqueous lubricant compositions can be used in a variety of applications. In general, they can be used as lubricant fluids for systems and applications as a substitute for conventional hydrocarbon-based lubricants.

[0232] The invention is thus not limited to any particular application of the aqueous lubricants according to the invention, the following development being given purely as a nonlimiting illustration.

[0233] Mechanical parts lubricated with a lubricant composition according to the invention may be made of any material conventionally used in the fields concerned, in particular metal, such as steel, galvanized steel, stainless steel, yellow metals, but also ceramic or polymer material. It is understood that the surface of these different materials may be coated, for example with a DLC (diamond-like carbon) coating.

[0234] By way of illustration of a conceivable application, an aqueous lubricant composition according to the invention may be intended for lubricating moving parts in a mechanical system, and more particularly intended for lubricating a mobile or stationary drive system.

[0235] An aqueous lubricant composition according to the invention may thus be used for lubricating and/or cooling gears, rolling bearings, or bearings such as rolling or sliding bearings, or engines.

[0236] For the purposes of the present invention, the term "drive system" is intended to denote a system comprising all the mechanical parts required for the intended mobile or stationary application and including at least one engine. This may be a combustion, gas, notably hydrogen, ammonia, electric or hybrid, drive system depending on the nature of the engine(s) included in the drive system: a combustion, gas, notably hydrogen, ammonia and/or electric engine.

[0237] For the purposes of the invention, a "stationary" drive system is a drive system that includes a stationary engine. It may find applications, for example, in electric power generation devices. In particular, it may be a gas drive system, in particular a stationary gas engine.

[0238] A "mobile" drive system is more particularly a drive system used in vehicles, including light vehicles, heavy-duty vehicles, "off-road" mobile machines and marine vehicles.

[0239] A mobile drive system may thus be a propulsion system for a vehicle, in particular an electric or hybrid vehicle.

[0240] For the purposes of the present invention, the term "propulsion system" denotes a system comprising the mechanical parts required for propelling a vehicle. The propulsion system more particularly encompasses an engine, for example an electric motor comprising the rotor-stator assembly of the power electronics (dedicated to regulating the speed), a transmission and optionally a battery. The battery itself generally consists of a set of electric accumulators known as cells.

[0241] An aqueous lubricant composition according to the invention advantageously allows effective action on fuel consumption via its impact on the friction forces generated

between the various components of motor vehicles. In particular, an aqueous lubricant composition proves most particularly advantageous for reducing friction in gearboxes, axle differentials and/or cylinder heads.

[0242] By thus reducing friction between moving parts in the vehicle's propulsion system, a lubricant composition according to the invention not only reduces wear, but also limits energy losses responsible for excess fuel consumption.

[0243] An aqueous lubricant composition according to the invention thus advantageously has good properties in terms of reducing the fuel consumption of motor vehicles, also known as the "Fuel Eco" properties, and thus helps to reduce CO_2 emissions.

[0244] An aqueous lubricant composition according to the invention may find an advantageous application for the lubrication and/or cooling of an electric or hybrid vehicle propulsion system, and more particularly of the motor, the power electronics, the transmission and/or the battery.

[0245] An aqueous composition according to the invention may be used both as a cooling fluid and as a lubricant, for example in a propulsion system of an electric or hybrid vehicle. Advantageously, a composition according to the invention simultaneously affords good properties in terms of cooling and lubrication of the parts of the propulsion system of an electric or hybrid vehicle, such as an electric motor of an electric or hybrid vehicle. It notably proves to be effective for cooling the power electronics and/or the rotor and/or the stator of an electric motor. It can also ensure lubrication of the rolling bearings located between the rotor and the stator of an electric motor of an electric or hybrid vehicle.

[0246] Also, a composition according to the invention advantageously makes it possible to effectively cool the battery present in an electric or hybrid vehicle.

[0247] Thus, advantageously, it is possible, for example, by using a single composition according to the invention, to ensure both the cooling of the battery and the lubrication of the transmission, in particular the step-down gear, in an electric or hybrid vehicle.

[0248] An aqueous lubricant composition according to the invention may be used as a running-in lubricant, for example for running-in mobile or stationary drive systems.

[0249] Specifically, new or reconditioned mechanical systems may require appropriate lubrication during initial start-ups, so as to prevent initial surface damage to parts until the mechanical system reaches optimum functioning.

[0250] As mentioned previously, an aqueous lubricant composition according to the invention may also find applications as a hydraulic fluid, in particular in hydraulic actuators (cylinders/motors) or machine assemblies on demand. In particular, hydraulic fluids are subject to constant mechanical and high shear stresses due to their constant passage through a pump so as to maintain an appropriate pressure in the hydraulic system.

[0251] An aqueous lubricant composition according to the invention advantageously allows friction forces and wear to be reduced under severe operating conditions, such as those encountered in hydraulic systems.

[0252] Thus, an aqueous lubricant composition according to the invention can be used for the lubrication of various moving parts in a hydraulic system. It may also be used for heat transfer between the various components of a hydraulic system.

[0253] All the applications detailed above are provided to illustrate certain advantageous uses of an aqueous lubricant composition according to the invention.

[0254] According to the invention, the particular, advantageous or preferred features of the composition according to the invention make it possible to define uses according to the invention that are also particular, advantageous or preferred.

EXAMPLE

[0255] The invention will now be described by means of the following examples, which are given as nonlimiting illustrations of the invention.

Evaluation of the Tribological Properties

[0256] The tribological properties can be evaluated by a test on a rotating ball-disk (also called a ball-plane) tribometer of the linear reciprocating tribometer type. This test notably allows the performance of lubricants to be evaluated in terms of friction under mixed/limited operating conditions, depending on the load, pressure or speed conditions applied.

[0257] The coefficient of friction of the lubricant compositions tested is determined at 40° C. using a hardened steel ball about 2 cm in diameter, for example 1.905 cm in diameter, on a hardened steel plane.

[0258] The tribometer may be a device from the Laboratoire de Tribologie Dynamique des Systèmes (LTDS). This device can place a steel ball and a steel plane in relative movement in order to determine the coefficients of friction for a given lubricant composition, while at the same time varying various properties such as speed, load and temperature. The hardened steel plane is of reference AISI 52100 with a mirror finish, and the ball is also of reference AISI 52100 made of hardened steel.

[0259] The load applied is 10 N and the rotation speed ranges from 1 mm/s to 2500 mm/s. In particular, the coefficient of friction is determined at a rotation speed of 3 mm/s.

[0260] Approximately 50 ml of the lubricant composition tested were placed in the device. The ball is engaged face to plane, said ball and said plane being actuated independently so as to create a mixed rolling/sliding contact.

[0261] The coefficient of friction is measured and recorded using a force sensor.

Dissolution Tests

[0262] The dissolution of all the ingredients in the lubricant composition is evaluated visually at the end of formulation. Dissolution is considered satisfactory if the composition is transparent. On the contrary, dissolution is insufficient if the composition is cloudy or contains a precipitate.

pH Measurement

[0263] The pH of the compositions is measured at the end of formulation, using a pH meter.

Example 1

Preparation of the Lubricant Compositions

[0264] A reference aqueous lubricant composition, not comprising gallic acid ester, was formulated by simply mixing the following components at room temperature, in the mass percentages indicated in Table 1 below. The percentages are thus expressed on a mass basis relative to the total mass of the composition.

[0265] The pH regulator is an alkanolamine such as dimethylethanolamine, and allows the pH of the composition to be maintained between 8 and 15.

TABLE 1

Composition	Reference
Deionized water [%]	51.94
Polyalkylene glycol [%]	11.94
Diethylene glycol [%]	33.52
Alkanolamine pH-regulating additive [%]	0.92
Other additives(*) [%]	1.68
pH	9.2

(*)Mixture of additives comprising one or more anticorrosion additives, one or more passivating agents, one or more antifoaming additives and/or one or more dyes.

[0266] Four aqueous lubricant compositions (I1, 12, 13 and 14) according to the invention are formulated by adding, at room temperature, a gallic acid ester to the reference composition, in the mass proportions detailed in Table 2 below.

TABLE 2

Composition	Composition I1 according to the invention	Composition I2 according to the invention	Composition I3 according to the invention	Composition I4 according to the invention
Reference composition [%]	99	99	99	99
Propyl gallate [%]	1	—	—	—
Butyl gallate [%]	—	1	—	—
Octyl gallate [%]	—	—	1	—
Lauryl gallate [%]	—	—	—	1

[0267] Four other aqueous lubricant compositions according to the invention (I5, I6, I7 and I8) are formulated according to the following protocol.

[0268] Polyalkylene glycol and diethylene glycol are added to deionized water in the following proportions: deionized water 3/7, diethylene glycol 3/7 and polyalkylene glycol 1/7. The solution is stirred for 15 minutes at about 60° C. in the presence of a magnetic stirrer.

[0269] The gallic acid ester is then added.

[0270] Finally, the pH-regulating additive (Triethanolamine (TEA) or dimethylethanolamine (DMEA)) is added to the formulation.

[0271] The mass proportions of compositions I5 to I8 are presented in Table 3 below.

TABLE 3

Composition	I5	I6	I7	I8
Deionized water [%]	42.21	42.21	41.95	41.95
Polyalkylene glycol [%]	14.08	14.08	14.0	14.0
Diethylene glycol [%]	42.21	42.21	41.95	41.95
Octyl gallate [%]	1	—	1	—
Lauryl gallate [%]	—	1	—	1
Triethanolamine [%]	0.5	0.5	—	—
Dimethylethanolamine [%]	—	—	1.1	1.1
pH	8.8	9.0	10.4	10.5

Example 2

Characterization of the Compositions

[0272] The coefficient of friction is determined for the reference composition and compositions (I1, I2, I3 and I4) according to the invention. These results are presented in Table 4 below.

TABLE 4

Composition	Reference	I1	I2	I3	I4
Coefficient of friction	0.20-0.22	0.12-0.14	0.12-0.14	0.04-0.06	0.04-0.06

[0273] It emerges from these examples that the compositions in accordance with the invention (I1, I2, I3 and I4) have a significantly reduced coefficient of friction compared with the reference composition not comprising the gallic acid ester.

[0274] Consequently, the aqueous lubricant compositions according to the invention offer entirely advantageous performance in terms of friction reduction, in particular under severe lubrication conditions.

[0275] The compositions according to the invention (I5, I6, I7 and I8) are transparent, reflecting good dissolution of the various ingredients they contain.

[0276] Consequently, the aqueous lubricant compositions according to the invention have a very good ability to dissolve the various compounds they comprise, in particular antifreeze compound(s), gallic acid ester(s) and polyalkylene glycol(s).

1. An aqueous lubricant composition comprising at least:
water;
at least one polyalkylene glycol;
at least one antifreeze compound chosen from glycols, preferably alkylene glycols; glycerol; diglycerol; triglycerol, and mixtures thereof;
at least one gallic acid ester; and
at least one pH-regulating additive for maintaining the pH of said lubricant composition between 8 and 15.

2. The aqueous lubricant composition as claimed in claim **1**, characterized in that the water is osmosed water, in particular deionized water.

3. The aqueous lubricant composition as claimed in claim **1** or **2**, comprising at least 20% by mass of water, in particular deionized water, preferably at least 30% by mass, notably between 35% and 90% by mass, more preferentially between 40% and 75% by mass of water, relative to the total mass of said composition.

4. The aqueous lubricant composition as claimed in any one of the preceding claims, characterized in that the pH-

regulating additive(s) are chosen from alkanolamines, in particular ethanolamines, and more particularly from dimethylethanolamine, triethanolamine, and a mixture thereof, and more particularly is dimethylethanolamine.

5. The aqueous lubricant composition as claimed in any one of the preceding claims, characterized in that the content of pH-regulating additive(s) is between 0.1% and 10% by mass, preferably between 0.5% and 5% by mass, relative to the total mass of the composition.

6. The aqueous lubricant composition as claimed in any one of the preceding claims, characterized in that said polyalkylene glycol(s) comprise at least 50% by mass, in particular at least 80% by mass, more preferentially at least 90% by mass of propylene oxide and/or ethylene oxide units, and in particular said polyalkylene glycol(s) are ethylene oxide/propylene oxide copolymers.

7. The aqueous lubricant composition as claimed in any one of the preceding claims, characterized in that said polyalkylene glycol(s) have a kinematic viscosity measured at 100° C. (KV100), according to the standard ASTM D445, of between 100 and 25 000 mm^2/s, in particular between 150 and 10 000 mm^2/s.

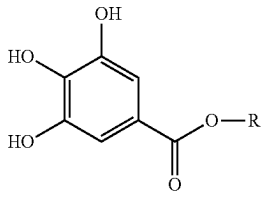
8. The aqueous lubricant composition as claimed in any one of the preceding claims, comprising at least 5.0% by mass of polyalkylene glycol(s), preferably between 5.0% and 50% by mass, more preferentially between 10% and 40% by mass, in particular between 10% and 20% by mass, relative to the total mass of the composition.

9. The aqueous lubricant composition as claimed in any one of the preceding claims, characterized in that said antifreeze compound is chosen from monoethylene glycol, diethylene glycol, propylene glycol, glycerol and mixtures thereof, and in particular is diethylene glycol.

10. The aqueous lubricant composition as claimed in any one of the preceding claims, comprising at least 5.0% by mass of antifreeze compound(s), preferably between 5.0% and 45% by mass, more preferentially between 10% and 35% by mass, in particular between 20% and 35% by mass, relative to the total mass of said composition.

11. The aqueous lubricant composition as claimed in any one of the preceding claims, characterized in that said gallic acid ester is obtained from a monoalcohol comprising between 1 and 24 carbon atoms, preferably between 3 and 20 carbon atoms, notably between 3 and 18 carbon atoms, more preferentially between 6 and 16 carbon atoms, for example between 8 and 14 carbon atoms, in particular chosen from 1-octanol and 1-dodecanol.

12. The aqueous lubricant composition as claimed in any one of the preceding claims, characterized in that said gallic acid ester is of formula (I):



in which R represents a linear or branched, saturated, mono- or polyunsaturated hydrocarbon-based chain, preferably a linear and saturated C_1-C_{24}, preferably C_3-C_{20}, more preferentially C_3-C_{18}, notably C_6-C_{16}, for example C_8-C_{14}, hydrocarbon-based chain, and preferably, said gallic acid ester is lauryl gallate.

13. The aqueous lubricant composition as claimed in any one of the preceding claims, comprising between 0.001% and 10% by mass of gallic acid ester(s), in particular between 0.01% and 5% by mass, more particularly between 0.1% and 2% by mass, relative to the total mass of the composition.

14. The aqueous lubricant composition as claimed in any one of the preceding claims, further comprising at least one additive chosen from antifoaming agents, biocides, corrosion inhibitors, antiwear and/or extreme-pressure additives, sequestrants, metal passivating agents, dyes, dispersants, emulsifying agents, and mixtures thereof, preferably chosen from antifoaming agents, corrosion inhibitors, metal passivating agents, dyes, and mixtures thereof.

15. The aqueous lubricant composition as claimed in any one of the preceding claims, comprising less than 5% by mass, preferably less than 2% by mass, more preferentially less than 1% by mass of water-insoluble oil(s), relative to the total mass of said composition, said composition more particularly being free of water-insoluble oil.

16. The use of an aqueous lubricant composition as defined in any one of the preceding claims, for the lubrication and/or cooling of moving parts in a mechanical system, for example for the lubrication and/or cooling of mobile or stationary drive systems, or as a hydraulic fluid.

17. The use of at least one gallic acid ester, in particular as defined in claim **11** or **12**, as an additive for improving the tribological properties, in particular in terms of friction reduction, of an aqueous composition further comprising at least: water, at least one polyalkylene glycol and at least one antifreeze compound chosen from glycols, and at least one pH-regulating additive which maintains the pH of said composition between 8 and 15.

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