

DESCRIPTION

TITLE: Lubricant composition for preventing corrosion and/or tribocorrosion of metalparts in an engine

The present invention relates to new lubricant compositions, in particular for engines, in particular useful for preventing corrosion and/or tribocorrosion of metal parts in an engine, and in particular in a two-stroke engine, such as a two-stroke marine engine. The present invention also relates to a method of passivating metal parts of an engine, in particular a two-stroke engine, such as a two-stroke marine engine.

Since 2011, the presence of excessive or even uncontrolled corrosion has become prevalent when engines are operated at very low loads (25% and less of the maximum load). This excessive corrosion is also present with the latest and most severe engine designs. Although in the near future (2020), sulphur levels in marine fuels will be lowered to comply with regulations (SO_x emissions), the problem of corrosion remains for many engine operators and more particularly for two-stroke engines.

The combustion of fuel oils generates acidic gases, in particular sulphur oxides (SO₃, formed by oxidation of SO₂), which come into contact with the metal parts of the engine. In the presence of water, SO₃ hydrolyses to sulphuric acid H₂SO₄, which is responsible for the corrosion of engine parts. Other acids, such as nitric acid, compounds with one or more carboxylic acid functions, or combinations of these acids, may also be responsible for corrosion and/or tribocorrosion of engine parts.

Acidic corrosion is located in the tribological system in the ring-piston-liner area. In this area on a lubricated engine, the friction observed is of the reciprocating sliding type.

In the case of marine engines, especially two-stroke marine engines, lubricant compositions are classified into two categories: Cylinder oils, which provide lubrication to the piston-cylinder assembly, and system oils, which provide lubrication to all moving parts other than the piston-cylinder assembly.

When the engine is running, the cylinder oil is spread over the cylinder and forms a thin, oily film between the piston and the cylinder wall. This film plays three roles:

- ensure separation between the two surfaces to avoid bond wear,
- neutralise sulphuric acid drops formed in the combustion chamber before they reach the cylinder and cause corrosion wear and/or tribocorrosion, and
- disperse any deposits that may form on each surface to keep them clean.

Currently used engine lubricant compositions, especially for marine engines, comprise a base oil to which dispersants and overbased detergents are added. These overbased detergents typically comprise a calcium carbonate (CaCO_3) core coated with a surfactant layer. Calcium carbonate reacts with sulphuric acid to form calcium sulphate (CaSO_4). The reduction of sulphuric acid in the medium allows the protection of parts against corrosion and/or tribocorrosion.

In order to ensure this protection, the lubricant compositions used must be sufficiently basic (in particular to neutralise the acid), which implies increasing the quantity of detergents included in these compositions.

Thus, lubricant compositions currently on the market have Base Numbers (BN) above 70.

However, the increase in the amount of detergents in these lubricant compositions leads to an increase in the number of CaCO_3 and CaSO_4 particles responsible for polishing (or abrasive wear) of the surfaces of the metal engine parts, and in particular of the cylinders of two-stroke engines, such as two-stroke marine engines. On the other hand, the use of currently available lubricant compositions does not fully protect metal engine parts from corrosion and/or tribocorrosion, and in particular metal parts of the two-stroke engine from tribocorrosion, when the friction is of the reciprocating sliding type.

There is therefore a benefit to providing lubricant compositions to improve the protection of metal parts of an engine, in particular a two-stroke engine, such as a two-stroke marine engine, against corrosion and/or tribocorrosion.

There is also a benefit to providing lubricant compositions that reduce their Base Number.

An objective of the present invention is to provide lubricant compositions for improving the protection of metal parts of an engine, typically a two-stroke engine, especially a two-stroke marine engine, against corrosion and/or tribocorrosion.

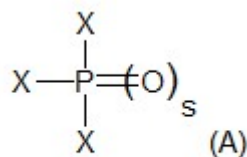
The present invention is aimed more particularly at the supply of cylinder oils for two-stroke engines, in particular for two-stroke marine engines.

A further objective of the present invention is to provide lubricant compositions with a reduced Base Number.

Further objectives will become apparent from the following description of the invention.

These objectives are fulfilled by the present invention which relates to a lubricant composition comprising:

- at least one base oil; and
- from 0.1% to 30%, preferably from 0.5% to 20%, advantageously from 1% to 10% by weight of a phosphorus ester compound of formula (A):



in which

s is 0 or 1; and

the radicals X represent, independently of each other, -OR' or R' moieties, where R' represents hydrogen or a linear or branched hydrocarbon moiety, preferably having from 1 to 36 carbon atoms, with the proviso that:

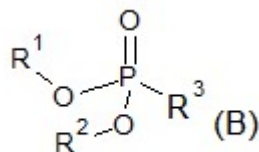
when s is 0, the three X radicals represent -OR' moieties, and

when s is 1, at least two of the three X radicals are -OR' moieties.

Preferably, R' represents a linear or branched alkyl moiety comprising from 1 to 36 carbon atoms, preferably from 2 to 30 carbon atoms, advantageously from 4 to 24 carbon atoms, or R' represents a linear or branched alkenyl moiety comprising from 2 to 36 carbon atoms, preferably from 2 to 30 carbon atoms, advantageously from 4 to 24 carbon atoms.

Preferentially, these objectives are fulfilled by the present invention which relates to a lubricant composition comprising:

- at least one base oil; and
- from 0.1% to 30%, preferably from 0.5% to 20%, advantageously from 1% to 10% by weight of a phosphorus ester compound of formula (B):



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in which:

- R^1 and R^2 , which may be the same or different, independently represent a linear or branched alkyl moiety comprising from 1 to 36 carbon atoms, preferably from 2 to 30 carbon atoms, advantageously from 4 to 24 carbon atoms, or R^1 and R^2 , which may be the same or different, independently represent a linear or branched alkenyl moiety comprising from 2 to 36 carbon atoms, preferably from 2 to 30 carbon atoms, advantageously from 4 to 24 carbon atoms; and
- R^3 represents hydrogen or a hydroxyl moiety (OH).

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Preferably, the alkenyl moiety (R^1 and/or R^2) according to the invention comprises at least one double bond. Preferably, said double bond is located at C-9, C-10 of the alkenyl moiety with respect to the phosphorus ester function.

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Preferably, the R^1 , R^2 or R^3 moiety does not comprise a sulphur or nitrogen atom.

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According to the invention, a hydrocarbon moiety is a linear or branched, saturated, partially or totally unsaturated chain comprising from 1 to 36 carbon atoms, preferably from 2 to 30 carbon atoms, advantageously from 4 to 24 carbon atoms.

According to a particular embodiment of the invention, the base oil included in the lubricating composition is selected from oils of mineral, synthetic or vegetable origin as well as mixtures thereof.

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The mineral or synthetic oils generally used in the application belong to one of the classes defined in the API classification as summarised in the table below.

[Table 1]

	Saturated	Sulphur content	Viscosity
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	content		index
Group 1 Mineral oils	< 90%	> 0.03%	$80 \leq VI < 120$
Group 2 Hydrocracked oils	$\geq 90\%$	$\leq 0.03\%$	$80 \leq VI < 120$
Group 3 Hydro-isomerised oils	$\geq 90\%$	$\leq 0.03\%$	≥ 120
Group 4	Polyalphaolefins (PAO)		
Group 5	Other bases not included in bases in groups 1 to 4		

Table 1: API classification of base oils

Group 1 mineral oils may be obtained by distillation of selected naphthenic or paraffinic crudes, followed by purification of these distillates by processes such as solvent extraction, solvent or catalytic dewaxing, hydrotreating or hydrogenation.

Group 2 and 3 oils are obtained by more severe purification processes, for example a combination of hydrotreating, hydrocracking, hydrogenation and catalytic dewaxing.

Examples of Group 4 and 5 synthetic bases include poly-alpha olefins, polybutenes, polyisobutenes, alkylbenzenes.

These base oils can be used alone or in a mixture. Mineral oil can be combined with synthetic oil.

Marine diesel two-stroke cylinder oils have a viscosity grade of SAE-40 to SAE-60, generally SAE-50 equivalent to a kinematic viscosity at 100 °C of between 16.3 and 21.9 mm²/s.

Grade 40 oils have a kinematic viscosity at 100 °C of between 12.5 and 16.3 mm²/s.

Grade 50 oils have a kinematic viscosity at 100 °C of between 16.3 and 21.9 mm²/s.

Grade 60 oils have a kinematic viscosity at 100 °C of between 21.9 and 26.1 mm²/s.

According to industry practice, it is preferred to formulate cylinder oils for two-stroke marine diesel engines with a kinematic viscosity at 100 °C between 18 and 21.5, preferably between 19 and 21.5 mm²/s.

This viscosity can be achieved by mixing additives and base oils, for example containing moiety 1 mineral bases such as Neutral Solvent bases (e.g. 500 NS or 600 NS) and Brightstock. Any other combination of mineral, synthetic or vegetable

bases which, when mixed with additives, have a viscosity compatible with the SAE-50 grade may be used.

Typically, a conventional formulation of cylinder lubricant for marine two-stroke diesel engines is of grade SAE-40 to SAE-60, preferably SAE-50 (according to the SAE J300 classification) and comprises at least 50% by weight of lubricating base oil of mineral and/or synthetic origin, suitable for use in marine engines, for example, of API Group 1 class, i.e. obtained by distillation of selected crude oils followed by purification of these distillates by processes such as solvent extraction, solvent or catalytic dewaxing, hydrotreating or hydrogenation. Their Viscosity Index (VI) is between 80 and 120; their sulphur content is greater than 0.03% and their saturated content is less than 90%.

Advantageously, the lubricant composition according to the invention comprises at least 50% by weight of base oil(s) relative to the total weight of the composition.

More advantageously, the lubricant composition according to the invention comprises at least 60% by weight, or even at least 70% by weight, of base oil(s) relative to the total weight of the composition.

More particularly advantageously, the lubricant composition according to the invention comprises from 60% to 99.9% by weight of base oils, preferably from 70% to 98% by weight of base oils, relative to the total weight of the composition.

Preferably, the lubricant composition according to the invention further comprises at least one additive selected from detergents, dispersants and mixtures thereof.

The detergents used in the lubricating compositions according to the present invention are well known to the person skilled in the art.

In the context of the present invention, detergents commonly used in the formulation of lubricating compositions are anionic compounds having a long lipophilic hydrocarbon chain and a hydrophilic head. The associated cation is a metal cation of an alkali or alkaline earth metal.

The detergents are preferably selected from alkali or alkaline earth metal salts of carboxylic acids, sulphonates, salicylates, naphthenates, and phenate salts.

The alkali and alkaline earth metals are preferably calcium, magnesium, sodium or barium.

These metal salts may contain the metal in approximately stoichiometric amounts. In this case, they are called non-overbased or "neutral" detergents, although they also provide a certain basicity. These "neutral" detergents typically have a BN, measured according to ASTM D2896, of less than 150 mg KOH/g, or less than 100, or even less than 80 mg KOH/g.

This type of so-called neutral detergents can contribute to the BN of the lubricants according to the present invention. Neutral detergents such as carboxylates, sulphonates, salicylates, phenates, naphthenates of alkali and alkaline earth metals, e.g. calcium, sodium, magnesium, barium, are used.

When the metal is in excess (above the stoichiometric amount), we are dealing with so-called overbased detergents. Their BN is high, e.g. above 150 mg KOH/g, typically between 200 and 700 mg KOH/g, usually between 250 and 450 mg KOH/g.

The excess metal giving the overbased character to the detergent is in the form of oil-insoluble metal salts, e.g. carbonate, hydroxide, oxalate, acetate, glutamate, preferably carbonate.

In the same overbased detergent, the metals of these insoluble salts may be the same as those of the oil-soluble detergents or they may be different. They are preferably chosen from calcium, magnesium, sodium or barium.

The overbased detergents are thus in the form of micelles composed of insoluble metal salts kept in suspension in the lubricant composition by the detergents in the form of oil-soluble metal salts.

Overbased detergents with only one type of detergent soluble metal salt will generally be named after the nature of the hydrophobic chain of that detergent salt.

Thus, they will be said to be of the carboxylate, phenate, salicylate, sulphonate or naphthenate type depending on whether the detergent is a carboxylate, phenate, salicylate, sulphonate or naphthenate respectively.

Overbased detergents are said to be of the mixed type if the micelles comprise multiple types of detergents, which differ from each other by the nature of their hydrophobic chain.

For use in the lubricant compositions according to the present invention, the oil-soluble metal salts are preferably carboxylates, phenates, sulphonates,

salicylates, and mixed phenate-sulphonate and/or salicylate detergents of calcium, magnesium, sodium or barium.

The insoluble metal salts providing the overbased character are alkali and alkaline earth metal carbonates, preferably calcium carbonate.

5 Preferably, the detergents used in the lubricating compositions according to the present invention are calcium carbonate overbased detergents selected from carboxylates, phenates, sulphonates, salicylates and mixed phenate-sulphonate-salicylate detergents.

10 Advantageously, the lubricant composition according to the invention may comprise from 3% to 40%, preferably from 5% to 30%, advantageously from 10% to 25% by weight of detergent(s) based on the total weight of the lubricant composition.

15 Dispersants are well-known additives used in the formulation of lubricating compositions, especially for marine applications. Their primary role is to keep in suspension the particles initially present or appearing in the lubricant composition during its use in the engine. They keep those particles from agglomerating by playing on steric hindrance. They may also have a synergistic effect on neutralisation.

20 In the context of the present invention, dispersants used as lubricant additives contain a polar moiety, associated with a relatively long hydrocarbon chain, generally containing from 50 to 400 carbon atoms. The polar moiety typically contains at least one nitrogen or oxygen element.

25 Succinic acid derivatives are dispersants that are particularly used as lubrication additives. Succinimides, obtained by condensation of succinic anhydrides and amines, succinic esters obtained by condensation of succinic anhydrides and alcohols or polyols are used in particular.

30 These compounds can then be treated with a variety of compounds including sulphur, oxygen, formaldehyde, carboxylic acids and boron or zinc containing compounds to produce, for example, borated succinimides or zinc blocked succinimides.

Mannich bases, obtained by polycondensation of alkyl-substituted phenols, formaldehyde and primary or secondary amines, are also compounds used as dispersants in lubricants.

Preferably, the dispersants according to the invention are chosen from succinimides, such as polyisobutylene bis-succinimides, optionally borated or zinc-blocked.

Advantageously, the lubricant composition according to the invention may comprise from 0.01% to 10%, preferably from 0.1% to 5%, advantageously from 0.5% to 3% by weight of dispersant(s) based on the total weight of the lubricant composition.

The lubricant composition may further comprise at least one anti-wear additive.

Preferably, the anti-wear additive is zinc dithiophosphate or ZnDTP. Also included in this category are various phosphorus, sulphur, nitrogen, chlorine and boron compounds.

There is a wide variety of anti-wear additives, but the most commonly used category is that of phospho-sulphur additives such as metal alkylthiophosphates, in particular zinc alkylthiophosphates, and more specifically zinc dialkyldithiophosphates or ZnDTPs.

Amine phosphates, polysulphides, especially sulphur olefins, are also commonly used anti-wear additives.

Anti-wear and extreme pressure additives of the nitrogenous and sulphurous type, such as metal dithiocarbamates, in particular molybdenum dithiocarbamate, are also commonly found in lubricant compositions. Glycerol esters are also anti-wear additives. Examples include mono-, di- and trioleates, monopalmitates and monomyristates.

According to a particular embodiment, the lubricant composition comprises, based on the total weight of the lubricant composition:

- from 50% to 96.9% by weight, preferably from 60 to 95% by weight, more preferably from 70 to 90% by weight, of base oil(s),
- from 0.1 to 30% by weight, preferably from 0.5 to 20% by weight, more preferably from 1 to 10% by weight, of one or more phosphorus ester compounds of formula (A), and
- from 3% to 40% by weight, preferably from 5% to 30% by weight, more preferably from 10% to 25% by weight, of detergent(s), and

- optionally from 0.01% to 10% by weight, preferably from 0.1 to 5% by weight, more preferably from 0.5% to 3% by weight, of dispersant(s).

According to a particular embodiment, the lubricant composition comprises,
5 based on the total weight of the lubricant composition:

- from 50% to 96.9% by weight, preferably from 60 to 95% by weight, more preferably from 70 to 90% by weight, of base oil(s),
- from 0.1 to 30% by weight, preferably from 0.5 to 20% by weight, more preferably from 1 to 10% by weight, of one or more phosphorus ester
10 compounds of formula (B), and
- from 3% to 40% by weight, preferably from 5% to 30% by weight, more preferably from 10% to 25% by weight, of detergent(s), and
- optionally from 0.01% to 10% by weight, preferably from 0.1 to 5% by weight, more preferably from 0.5% to 3% by weight, of dispersant(s).

15 According to a particular embodiment, the lubricant composition comprises,
based on the total weight of the lubricant composition:

- from 60% to 99% by weight, preferably from 60 to 95% by weight, more preferably from 70 to 90% by weight, of base oil(s),
- from 0.1 to 30% by weight, preferably from 0.5 to 20% by weight, more preferably from 1 to 10% by weight, of one or more phosphorus ester
20 compounds of formula (A), and
- from 0.01 to 10% by weight, preferably 0.1 to 5% by weight, more preferably 0.5 to 3% by weight, of dispersant(s), and
- optionally from 3 to 40% by weight, preferably from 5 to 30% by weight,
25 more preferably from 10 to 25% by weight, of detergent(s).

According to a particular embodiment, the lubricant composition comprises,
based on the total weight of the lubricant composition:

- from 60% to 99% by weight, preferably from 60 to 95% by weight, more preferably from 70 to 90% by weight, of base oil(s),
- from 0.1 to 30% by weight, preferably from 0.5 to 20% by weight, more preferably from 1 to 10% by weight, of one or more phosphorus ester
30 compounds of formula (B), and

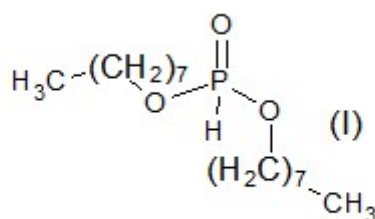
- from 0.01 to 10% by weight, preferably 0.1 to 5% by weight, more preferably 0.5 to 3% by weight, of dispersant(s), and
- optionally from 3 to 40% by weight, preferably from 5 to 30% by weight, more preferably from 10 to 25% by weight, of detergent(s).

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The lubricant composition may also include any type of functional additives suitable for their use, for example anti-foaming additives which may be for example polar polymers such as polymethylsiloxanes, polyacrylates, anti-oxidant additives for example of the phenolic or amine type and/or anti-rust additives, for example organometallic compounds or thiadiazoles. These are known to the skilled person.

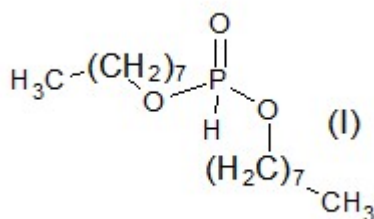
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According to one embodiment of the invention, the compound of formula (A) is the following compound (I):



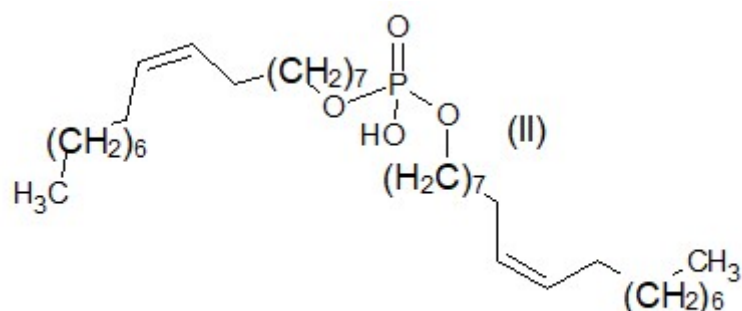
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According to one embodiment of the invention, the compound of formula (B) is the following compound (I):

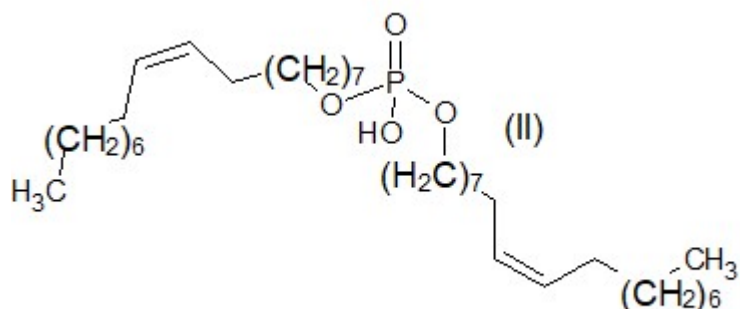


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According to another embodiment of the invention, the compound of formula (A) is the following compound (II):



According to another embodiment of the invention, the compound of formula (B) is the following compound (II):



According to a particular embodiment, the lubricant composition comprises, based on the total weight of the lubricant composition:

- from 50% to 96.9% by weight, preferably from 60 to 95% by weight, more preferably from 70 to 90% by weight, of base oil(s),
- from 0.1 to 30% by weight, preferably from 0.5 to 20% by weight, more preferably from 1 to 10% by weight, of one or more phosphorus ester compounds including at least one compound of formula (I) or formula (II) defined above, and
- from 3 to 40% by weight, preferably from 5 to 30% by weight, more preferably from 10 to 25% by weight, of detergent(s) comprising at least one phenate or sulphonate overbased detergent, and
- optionally from 0.01 to 10% by weight, preferably from 0.1 to 5% by weight, more preferably from 0.5 to 3% by weight, of dispersant(s).

According to a particular embodiment, the lubricant composition comprises, based on the total weight of the lubricant composition:

- from 60% to 99% by weight, preferably from 60 to 95% by weight, more preferably from 70 to 90% by weight, of base oil(s),
- from 0.1 to 30% by weight, preferably from 0.5 to 20% by weight, more preferably from 1 to 10% by weight, of one or more phosphorus ester compounds including at least one compound of formula (I) or formula (II) defined above, and
- from 0.01 to 10% by weight, preferably 0.1 to 5% by weight, more preferably 0.5 to 3% by weight, of dispersant(s) selected from succinimides, and
- optionally from 3 to 40% by weight, preferably from 5 to 30% by weight, more preferably from 10 to 25% by weight, of detergent(s).

The present invention also relates to the use of the lubricant composition according to the invention for the lubrication of at least one metal part of an engine, such as a two-stroke engine and in particular a two-stroke marine engine.

Preferably, the use of the lubricant composition according to the invention prevents and/or reduces corrosion and/or tribocorrosion of said metal part of said engine.

The present invention also relates to a method of lubricating at least one metal part of an engine, such as a two-stroke engine and in particular a two-stroke marine engine, comprising bringing said part of an engine in contact with the lubricating composition according to the invention.

The present invention also relates to the use of a compound of formula (A) according to the invention in a lubricating composition comprising at least one base oil for preventing and/or reducing corrosion and/or tribocorrosion of at least one metal part of an engine, such as a two-stroke engine and in particular a two-stroke marine engine.

The present invention also relates to the use of a compound of formula (B) according to the invention in a lubricating composition comprising at least one base oil for preventing and/or reducing corrosion and/or tribocorrosion of at least one

metal part of an engine, such as a two-stroke engine and in particular a two-stroke marine engine.

5 The present invention also relates to a method of preventing and/or reducing corrosion and/or tribocorrosion of at least one metal part of an engine, such as a two-stroke engine and in particular a two-stroke marine engine, comprising lubricating said metal part with a lubricating composition according to the invention.

10 The present invention also relates to the use of the lubricant composition according to the invention for the passivation of at least one metal part of an engine, such as a two-stroke engine and in particular a two-stroke marine engine.

15 The present invention also relates to a method of passivating at least one metal part of an engine comprising at least one step of bringing said metal part into contact with the lubricating composition according to the invention.

20 The present invention also relates to the use of a compound of formula (A) according to the invention in a lubricating composition comprising at least one base oil for passivating at least one metal part of an engine, such as a two-stroke engine and in particular a two-stroke marine engine.

25 The present invention also relates to the use of a compound of formula (B) according to the invention in a lubricating composition comprising at least one base oil for passivating at least one metal part of an engine, such as a two-stroke engine and in particular a two-stroke marine engine.

Preferably, the metal part according to the invention is a cylinder or a piston.
Advantageously, the metal part is made of cast iron.

30 Preferably, the engine according to the invention is a two-stroke engine.
Preferably, the engine is a two-stroke marine engine.

Preferably, the engine is a heavy fuel oil burning engine. For the purposes of this invention, "heavy fuel oil" means heavy fractions from the distillation of oil, possibly with additives.

For the purposes of this invention, “corrosion” means the alteration of a material, preferably metal, by chemical reaction with an oxidant. Preferably, this oxidant is an acid. Preferably, this acid is sulphuric acid H_2SO_4 .

For the purposes of this invention, “tribocorrosion” means a process leading to the degradation and wear of a metallic material under the combined action of friction and corrosion as defined above.

Advantageously, the compound of formula (A) defined herein is used in a cylinder lubricant composition for reducing acid tribocorrosion on the cylinders and pistons of a two-stroke engine, such as a two-stroke marine engine.

Even more advantageously, the compound of formula (B) defined herein is used in a cylinder lubricant composition for reducing acid tribocorrosion on the cylinders and pistons of a two-stroke engine, such as a two-stroke marine engine.

FIGURES

[Fig 1] Figure 1 shows the depth profiles of cast-iron plates obtained after a tribological test conducted in the presence of the lubricant composition according to the invention CL2 and the comparative composition CC1.

The present invention will now be described with the help of non-limiting examples.

Example 1: Lubricant compositions

The compositions in Table 2 (CL: lubricant composition according to the invention; CC: comparative lubricant composition) were prepared by mixing the dispersant and/or detergents and the additive in a base oil at 60 °C.

[Table 2]

Lubricating composition	Base oil (% by weight)	Dispersant (% by weight)	Phenate detergent (% by weight)	Sulphonate detergent (% by weight)	Additive (% by weight)

CL1	mixture of two group I base oils (75.3%)	Polyisobutylene succinimide (1.1%)	phenate with a BN of 250 (13.6%)	sulphonate with a BN of 400 (5.3%)	Compound of formula (I) (5%)
CL2	mixture of two group I base oils (75.3%)	Polyisobutylene succinimide (1.1%)	phenate with a BN of 250 (13.6%)	sulphonate with a BN of 400 (5.3%)	Compound of formula (II) (5%)
CC1	mixture of two group I base oils (79.2%)	Polyisobutylene succinimide (1.2%)	phenate with a BN of 250 (14.3%)	sulphonate with a BN of 400 (5.3%)	-

Table 2: Lubricant compositions according to the invention and comparative lubricant compositions

Example 2: Wear depth test results

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Tribological tests were carried out on an alternative Biceri tribometer using steel rods (EN31) with a diameter of 6 mm and a radius of curvature of 50 mm, and cast iron platens (FT 25) polished with 800 grit SiC sandpaper. The steel rods were also polished to a roughness Ra of between 50 and 100 nm. In addition, the areas of the cast-iron plates outside the friction zone have been coated with a resin. This resin is removed at the end of the tests. In this way, the resin-coated areas are not corroded during testing and serve as a standard for measuring the depth of wear marks due to corrosion phenomena.

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Prior to each test, the lubricant composition was heated to 100 °C and brought into contact with a 5 M sulphuric acid solution (27% by weight) at room temperature using a "T" arrangement. The lubricant composition is fed through the main channel and the acid solution is fed through a channel perpendicular to the main channel.

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The conditions for these tests are as follows:

- Temperature: 100 °C
- Pressure: 0.67 GPa
- Speed: 0.02 m/s

- Trace length: 5 mm
- Duration: 6 hrs.

At the end of each test, the corrosion products are removed with anethylenediaminetetraacetic acid (EDTA) solution, and the wear of the cast iron plates is analysed by white light interferometry, which allows a 3D profile of the wear scar produced by corrosion and/or tribocorrosion to be obtained.

These 3D profiles provide depth profiles of the wear scar. Figure 1 shows the depth profiles of the cast-iron plates obtained after a tribological test as described above and conducted in the presence of the lubricant composition according to the invention CL2 and the comparative composition CC1.

The results of these tests show that in the absence of an additive, the cast-iron plate corrodes in the areas not in contact with the steel rod (non-contact areas), and tribocorrosion wear is also observed in the area in contact with the rod. The presence of additives improves the protection against corrosion and tribocorrosion. Indeed, without wishing to be bound by any theory, the additives make it possible to create a second layer of protection which is added to the neutralisation of the acid drops by the detergent by forming a physical barrier between the surface of the metal part and the oil of the lubricant composition, which prevents corrosion phenomena.

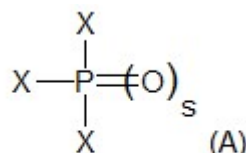
The lubricant compositions according to the invention, and more particularly the compositions comprising the compounds of formula (I) or (II) (CL1 and CL2), make it possible to protect the cast-iron plate effectively against both corrosion (non-contact zones) and tribocorrosion (contact zone).

CLAIMS

1. A lubricant composition comprising:

- at least one base oil; and

- from 0.1% to 30% by weight of a phosphorus ester compound of formula (A):



in which

s is 0 or 1; and

the radicals X represent, independently of each other, -OR' or R' moieties, where R' represents hydrogen or a linear or branched hydrocarbon moiety, preferably having from 1 to 36 carbon atoms, with the proviso that:

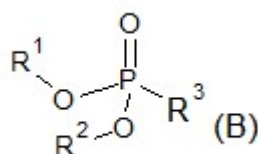
when s is 0, the three X radicals represent -OR' moieties, and

when s is 1, at least two of the three X radicals are -OR' moieties.

2. The lubricant composition according to claim 1, comprising:

- at least one base oil; and

- from 0.1% to 30% by weight of a phosphorus ester compound of formula (B):



defined as:

- R¹ and R², which may be the same or different, independently represent a linear or branched alkyl moiety comprising from 1 to 36 carbon atoms, or R¹ and R², which may be the same or different, independently represent a linear or branched alkenyl moiety comprising from 2 to 36 carbon atoms; and

- R³ represents hydrogen or a hydroxyl moiety.

3. The composition according to claim 1 or 2, further comprising at least one additive selected from detergents, dispersants and mixtures thereof.

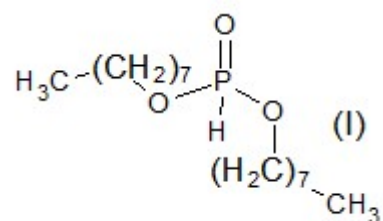
4. The composition according to claim 3, wherein:

- the amount of detergent varies from 3% to 40%, preferably from 5% to 30%, advantageously from 10% to 25% by weight, based on the total weight of the lubricant composition; and/or

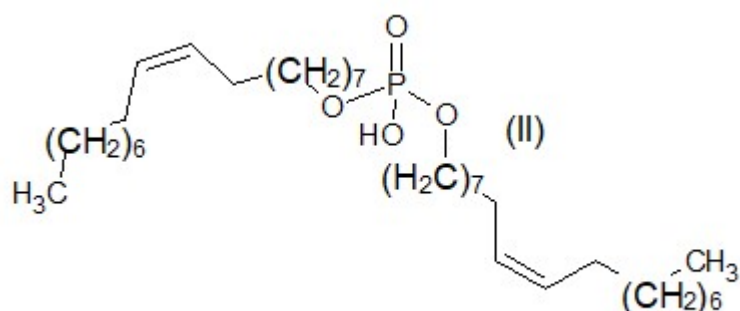
- the amount of dispersant varies from 0.01% to 10%, preferably from 0.1% to 5%, advantageously from 0.5% to 3% by weight, based on the total weight of the lubricant composition.

5. The composition according to claim 3 or 4, wherein the detergents are calcium carbonate overbased detergents selected from carboxylates, phenates, sulphonates, salicylates and mixed phenate-sulphonate-salicylate detergents.

6. The composition according to any of the preceding claims, wherein the compound of formula (A) or the compound of formula (B) corresponds to the compound of formula (I) defined by the following formula:



7. The composition according to any of the claims 1 to 5, wherein the compound of formula (A) or the compound of formula (B) corresponds to the compound of formula (II) defined by the following formula:



8. Use of a compound of formula (A) or formula (B) as defined in claims 1, 2, 6 or 7 in a lubricating composition comprising at least one base oil for preventing and/or reducing corrosion and/or tribocorrosion of at least one metal part of an engine, in particular a two-stroke engine, for example a two-stroke marine engine.

9. Use of the composition according to any one of claims 1 to 7 for the prevention and/or reduction of corrosion and/or tribocorrosion of at least one metal part of an engine, in particular a two-stroke engine, for example a two-stroke marine engine.

10. A method of passivating at least one metal part of an engine, in particular a two-stroke engine, for example a two-stroke marine engine, comprising at least one step of bringing said metal part into contact with a lubricating composition defined according to any of claims 1 to 7.