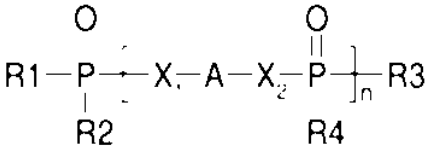
CLAIMS

1. Use of at least one anti-wear additive in an oil, said at least one anti-wear additive comprising at least one polyphosphorus compound of formula (I)

(I) 

wherein

each of R1, R2, R3 and R4 is independently selected from: an alkyl, O-alkyl, aryl, or O-aryl group.

A is a divalent group selected from an alkylene group comprising 7 to 36 carbon atoms or a branched alkylene group comprising 6 to 36 carbon atoms, a monocyclic polycyclic or polyaromatic arylene group, or aralkylene group,

each of X_1, and X_2 is independently a single bond, an oxygen atom or a nitrogen atom, and

n is an integer ranging between 1 and 5,

to reduce and/or prevent the neurotoxicity of said oil, and preferably a turbine oil.

2. Use according to claim 1, wherein said oil and/or said at least anti-wear additive does not comprise tricresyl phosphate or does not comprise any additive(s) other than the polyphosphorus compound(s) of formula (I).

3. Use according to any one of the preceding claims, wherein

when A is a monocyclic arylene group, X_1 and X_2 are diametrically opposed, in particular at the 1,4-position when the monocyclic arylene group comprises 6 carbon atoms;

preferably when A is a phenylene, X1 and X2 are not in the ortho or meta position unless at least one and preferably all of the groups of R1, R2, R3 and R4 are O-phenyl groups substituted by two methyl groups, in particular in the 2,6-position or unless the phenylene is substituted by an O-diphenylphosphate.

4. Use according to any one of the preceding claims, wherein when A is a polycyclic arylene group or a polyaromatic arylene group, X_1 and X_2 are diametrically opposed, preferably when A is a naphthalene, X1 and X2 are diametrically opposed, typically when A is a naphthalene, X1 and X2 are not in the ortho or meta position.

5. Use according to any one of the preceding claims, wherein the oil is selected from the group consisting of oils for aircraft or aeroderivative turbines, helicopter transmission oils and weapon fluids.

6. Use according to any one of the preceding claims, wherein R1, R2, R3 and R4 are O-phenyl group or O-dimethylphenyl groups, such as O-2,6-dimethylphenyl.

7. Use according to any one of the preceding claims 1 to 6, wherein A is selected from the group consisting of a 1,4-phenyl, 4,4′-biphenyl, 4,4′-diphenylthioether, 4,4′-diphenylether, 1,3-(5 O-[(diphenyl)phosphate)]phenyl, 1,3-(2-ethyl-2-butyl)propyl, 1,3-(2-ethyl-2-[methyl-O-diphenyl phosphate])propyl, 4,4′-[diphenyl(dimethyl)-methylidene], 2,2′-benzophenone, 2,7-naphthalene, 1,2-ethyl, 4,4′-[diphenylphenylethylidene], 4,4′-diphenylsulfone, 4,4′-diphenyl-hexafluoropropane, 1,4-[(2-phenyl)phenyl], 1,4[(2,5-ditertbutyl)phenyl], 1,4-[(2-chloro)phenyl], 4,4′-benzophenone, 1-hydroxy-3-thiophenyl, 1,6-hexyl, 1,4-naphthalene, 2,6-anthracene, 9,10-anthracene, 1,10-decyl, 1,12-n-dodecyl, 2,5-dimethyl-2,5-hexyl, 1,12-dodecyl and 1,3-naphthalene group.

8. Use according to any one of the preceding claims 1 to 6, wherein A is an optionally substituted alkylene group, a substituted monocyclic arylene group or a polycyclic arylene group wherein at least two rings are linked by at least a covalent bond between two distinct atoms each belonging to one of the rings, the covalent bond between the two rings being interrupted by at least one heteroatom or heteroatomic group.

9. Use according to any one of the preceding claims 1 to 7 and 8 (partially), wherein the polyphosphorus compound is selected from the group consisting of:

- hydroquinone bis(diphenylphosphate) HDP,
- 4,4′-dihydroxybiphenyl bis(diphenylphosphate) and oligomers thereof,
- 4,4′-dihydroxydiphenyl thioether bis(diphenylphosphate),
- 4,4′-dihydroxydiphenyl ether bis(diphenylphosphate),
- 1,3,5-phloroglucinol tris((diphenylphosphate)),
- 2-butyl 2-ethyl 1,3-propanediol bis(diphenylphosphate),
- trimethylol propane tris(diphenylphosphate),
- 4,4′-dihydroxydiphenyl phenylethylidene bis(diphenylphosphate),
- 4,4′-dihydroxydiphenyl sulfone bis(diphenylphosphate),
- 4,4′-dihydroxybenzophenone bis(diphenylphosphate),
- 2,2′-dihydroxybenzophenone bis(diphenylphosphate),
- 4,4′-dihydroxydiphenyl hexafluoropropane bis(diphenylphosphate),
- 1,4-dihydroxynaphthalene bis(diphenylphosphate),
- 1,3-dihydroxynaphthalene bis(diphenylphosphate),
- 2,7-dihydroxynaphthalene bis(diphenylphosphate),
- ethanolamine diphenylphosphate diphenylphosphoroamidate,
- 4,4′-diaminodiphenyl ether bis(diphenylphosphoroamidate),
- 2,6-dihydroxyanthracene bis(diphenylphosphate),
- 9,10-dihydroxyanthracene bis(diphenylphosphate),
- 1,4-dihydroxy[(2-phenyl)phenyl] bis(diphenylphosphate),
- 1,4-dihydroxy[(2,5-diterbutyl)phenyl] bis(diphenylphosphate),
- 1,4-dihydroxy[(2-chloro)phenyl] bis(diphenylphosphate),
- 1,3-dihydroxythiophene bis(diphenylphosphate),

- 1,6-hexanediol bis(bis(diphenylphosphate),
- 1,10-decanediol bis(diphenylphosphate),
- 2,5-dimethyl 2,5-hexanediol bis(diphenylphosphate),
- 1,12-n-dodecanediol bis(diphenylphosphate),
- tetrakis(2,6-dimethylphenyl)-m-phenylene bisphosphate,
- tetrakis(2,6-dimethylphenyl)-p-phenylene bisphosphate,
- phenylhydroquinone bis(diphenylphosphate) DPP,
- tert-butyl hydroquinone bis(diphenylphosphate),
- 2,5-di-tert-butyl hydroquinone bis(diphenylphosphate),
- 1,4-dihydroxynaphthalene bis(diphenylphosphate),
- 2,7-dihydroxynaphthalene bis(diphenylphosphate),
- 4,4′-dihydroxybenzophenone bis(diphenylphosphate),
- bis(4-hydroxyphenyl)sulfone bis(diphénylphosphate),

4,4′-(hexafluoroisopropylidene) bis(diphenylphosphate),

- 4,4′-(α-méthylbenzylidene)bisphenol bis(diphenylphosphate),
- 1,1-bis-(4-hydroxyphényl)cyclohexane) bis(diphenylphosphate),
- 9,9-bis(4-hydroxyphenyl)fluorene bis(diphenylphosphate),
- 1,1,1-Tris(4-hydroxyphényl)ethane tris(diphénylphosphate), and

any mixtures thereof.

10. Use according to any one of the preceding claims 1 to 9, wherein the oil further comprises an ester base and at least one amine antioxidant.

11. Use according to any one of the preceding claims 1 to 10, wherein the at least polyphosphorus compound is present in the oil in an amount of from 0.1 to 10 wt. % by weight preferably 0.5 to 5 wt. % by weight, based on the total weight of the oil.

12. Use according to any one of the preceding claims, wherein the 50% inhibitory concentration of said at least one compound of formula (I) on the biological activity of an acetylcholinesterase (AChE) enzyme, called IC_{50} hAChE is greater than or equal to 15 mg/L, and on the activity on a butyrylcholinesterase enzyme, called IC_{50} eqBuChE is greater than or equal to 50 mg/L, preferably equal to or greater than 55 mg/L, in particular equal to or greater than 60 mg/L and typically equal to or greater than 70 mg/L.

13. Use according to any one of the preceding claims, wherein the compound(s) of formula (I) belong to cluster 3 determined according to molecular modelling by spherical harmonics as described in the publication “Benchmarking of HPCC: A novel 3D molecular representation combining shape and pharmacophoric descriptors for efficient molecular similarity assessments», Karaboga *et al.* 2013 Journal of Molecular Graphics and Modelling 41; 20-30.

14. Use according to any one of the preceding claims, wherein the compound(s) of formula (I) have a percentage value (%) by quantitative structure activity relationship (QSAR) modelling

- lower than or equal to 0.70%, preferably lower than or equal to 0.50% and typically lower than or equal to 0.15% for the measurement of neurotoxicity, named neurotoxic QSAR, and

- lower than or equal to 1.5%, preferably lower than or equal to 1.15% and typically lower than or equal to 0.55% for the measurement of reprotoxicity, named reprotoxic QSAR.