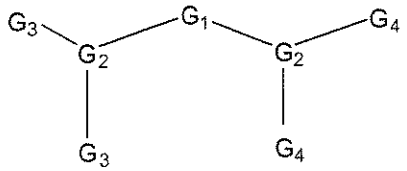
Although the aforementioned bisphosphites are good complexing ligands for rhodium-based hydroformylation catalyst systems, it is desirable to develop novel easily obtainable phosphites to further improve their efficacy in hydroformylation for example.

It is an object of the ~~present invention~~embodiments disclosed herein to prepare organic compounds which, in terms of their structure, can be categorized as tetraphenols, and convert them into their phosphorus derivatives.

It is also an object ~~in this connection for the~~of the embodiments disclosed herein to provide a method of preparing the organic compounds as well as the organic phosphorus compounds derived therefrom to be technically and economically undemanding. The focus in this connection is on a modular construction of the organic phosphorus compounds in order that varied structures may be generated in a few steps and also that starting materials conveniently available on a large industrial scale may be used for this.

These phosphorus derivatives, or the organic phosphorus compounds mentioned at the beginning, are further processed with transition metals to form catalytically active compositions. It is further an object to employ these catalytically active compositions in reactions of small molecules, for example CO, HCN, hydrogen or else amines, in pure form as well as mixed, with unsaturated hydrocarbon compounds. It is also an object that these catalytically active compositions used in the hydroformylation of unsaturated hydrocarbon compounds, for example, have a long on-stream life and hence the organic phosphorus compounds used as ligands have a low sensitivity to hydrolysis as well as a high selectivity to the linear, i.e. n-hydroformylated, product.

The ~~invention~~disclosure provides organic compounds of formula 1

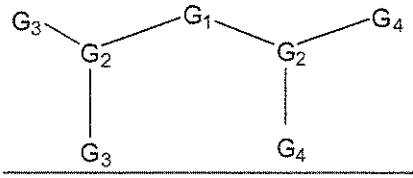


1

where:
G1 is an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 by a monovalent bond in each case;
G2 is an alkyl radical and is connected to G1, G3 and/or G4 by a monovalent bond in each case;

G3 and G4 are the same or different, are each substituted by an OH group and are each an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 by a monovalent bond in each case.

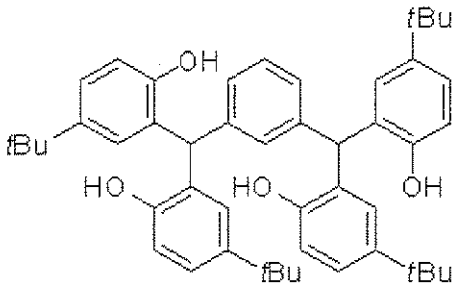
In a first aspect, there is provided an organic compound of formula 1



1

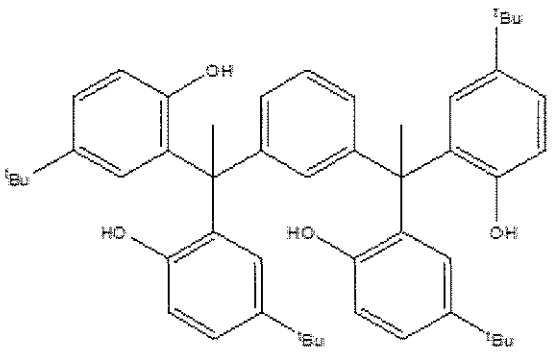
selected out of the group comprising:

4,4',4",4"'-Tetra-t-butyl-2,2',2",2"'-(phenylenemethandiyl)tetraphenol according to formula TP0



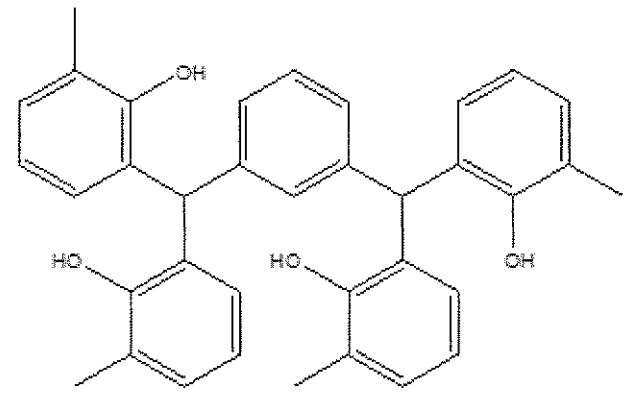
TP0;

4,4',4",4"'-Tetra-t-butyl-2,2',2",2"'-(phenylenemethandiyl)tetraphenol according to formula TP'0



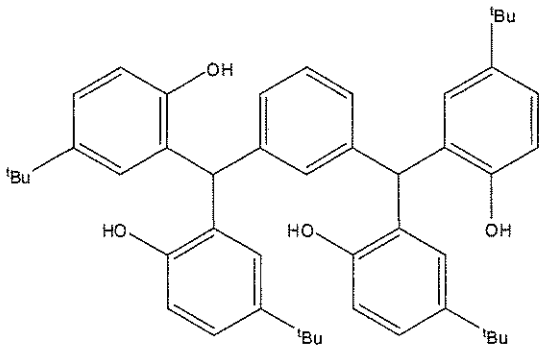
TP'0;

6,6',6",6"'-Tetra-o-methyl-2,2',2",2"'-(phenylenemethanediyl)tetraphenol according to formula TP"0

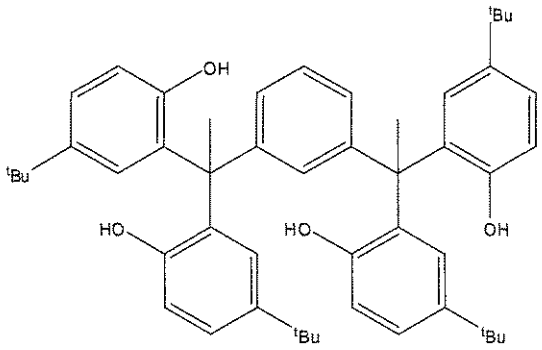


TP"0

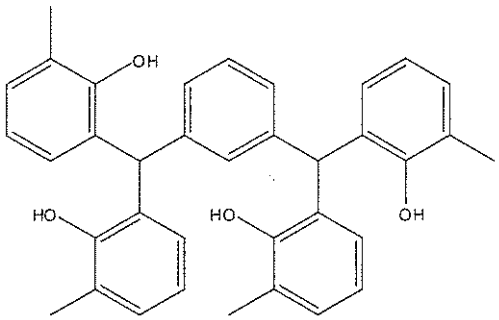
In a preferable embodiment, the variety of possible structures derivable from formula 1 reduces as a result of the following restrictions being introduced, viz.:
G1 is an at least disubstituted 1,2-, 1,3- or 1,4-phenylene radical;
G2 is a C1-alkyl radical with tertiary or quaternary substitution;
G3 and G4 are the same and are each an at least disubstituted aromatic radical having one OH group in each case and selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution.
Exemplary of this preferable embodiment are the following structures wherein G1 has a 1,3-substitution:



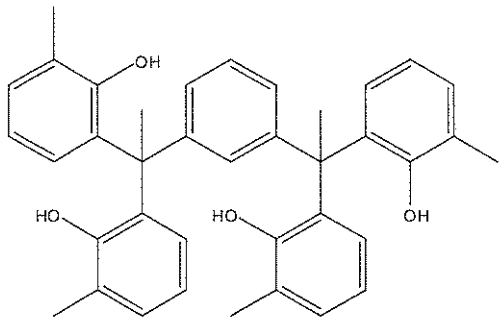
11



12



13



14

Exemplary representatives of this embodiment are reproduced in formulae 11 to 26 and also 29 to 31 for example. They are prepared as hereinbelow disclosed in the preparation examples according to the ~~invention~~disclosure.

In another preferable embodiment according to formula 1:

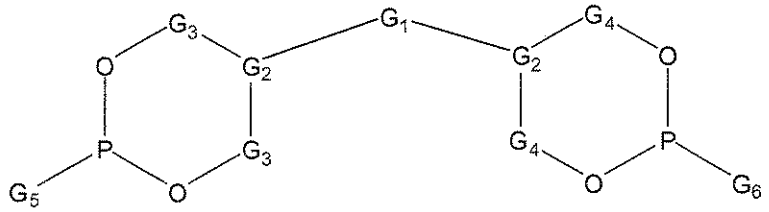
G1 is a 1,3-disubstituted phenylene radical;

G2 is a C1-alkyl radical substituted with hydrogen, methyl, ethyl, isopropyl, isobutyl, trifluoromethyl or aryl;

G3 and G4 are the same and an aromatic radical trisubstituted with OH and also 2 tert-butyl groups.

Claimed representatives of this embodiment are disclosed for example in formulae 12, 15, 16 and 18 and are synthesizable on the basis of preparation examples according to the ~~invention~~disclosure. In the preparation examples according to the ~~invention~~disclosure, the claimed representatives are designated as TP0, TP'0 and TP''0 for clarity.

The ~~invention~~disclosure further provides organic phosphorus compounds of formula 2:



2

where:

O in each occurrence is an oxygen atom,

P in each occurrence is a phosphorus atom,

G1 is an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 by a monovalent bond in each case;

G2 is an alkyl radical and is connected to G1, G3 and/or G4 by a monovalent bond in each case;

G3 and G4 are the same or different and are each an at least monosubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 and O by a monovalent bond in each case;

G5 and G6 are each identical or different units connected to P by a monovalent bond and selected from the group O-alkyl, O-aryl, O-acyl, O-heteroaryl, O-cycloalkyl, O-silyl, acyl, alkyl, aryl, heteroaryl, cycloalkyl, perfluoroalkyl, N-acyl, N-alkyl, N-aryl, N-heteroaryl, N-cycloalkyl, N-silyl.

In a particular embodiment of formula 2:

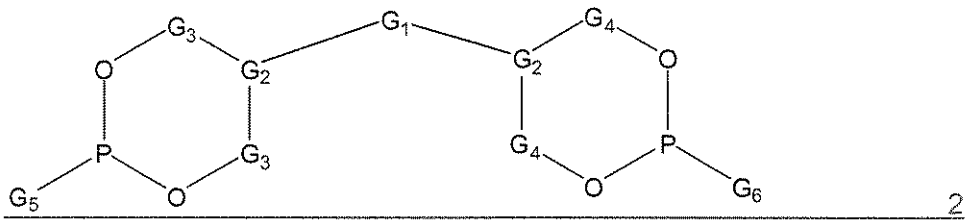
G1 is an at least disubstituted 1,2-, 1,3- or 1,4-phenylene radical;

G2 is a C1-alkyl radical with tertiary or quaternary substitution;

G3 and G4 are the same and are each an at least monosubstituted aromatic radical and selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution;

G5 and G6 are the same and selected from the group O-alkyl, O-aryl, O-acyl, O-heteroaryl, O-cycloalkyl, O-silyl, acyl, alkyl, aryl, heteroaryl, cycloalkyl, perfluoroalkyl, N-alkyl, N-aryl, N-heteroaryl, N-cycloalkyl, N-silyl.

In a second aspect, there is provided an organic phosphorus compound of formula 2:



2

wherein:

G1 is at least a disubstituted 1,3-phenylene radical;

G2 represents an alkyl radical which is bound monovalent to each G1, G3 and/or G4;

G3 and G4 are identical or different and at least a monosubstituted cyclic structure, selected out of the group of aromatic, heteroaromatic, fused aromatic or fused heteroaromatic systems containing arbitrary further substitution, which is bound monovalent to each G2 and O;

G5 and G6 are each identical or different monovalent units bound to P selected out of the group of O-alkyl, O-aryl, O-acyl, O-heteroaryl, O-cycloalkyl, O-silyl, acyl, alkyl, aryl, heteroaryl, cycloalkyl, perfluoroalkyl, N-acyl, N-alkyl, N-aryl, N-heteroaryl, N-cycloalkyl, N-silyl.

In a particularly preferable embodiment of formula 2:

G1 is a 1,3-disubstituted phenylene radical;

G2 is a C1-alkyl radical substituted with hydrogen or methyl;

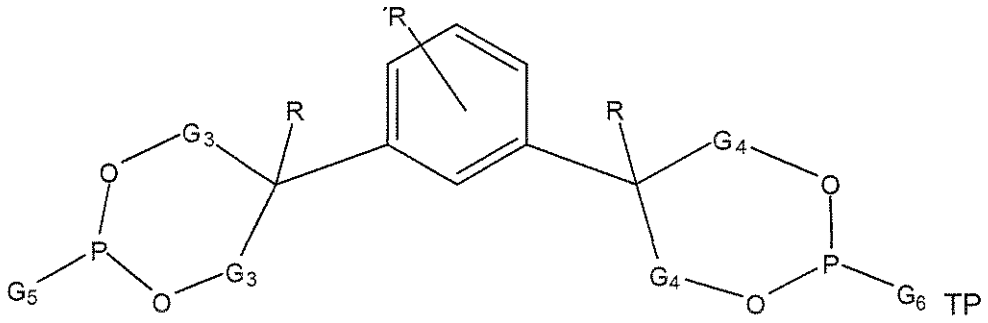
G3 and G4 are the same and selected from the group tert-butylphenoxy, methoxy-tert-butylphenoxy or di-tert-butylphenoxy;

G5 and G6 are the same and selected from the group tert-butylphenoxy, methoxy-tert-butylphenoxy, naphthoxy, di-tert-butylphenoxy, methyl-tert-butylphenoxy or pyrrole.

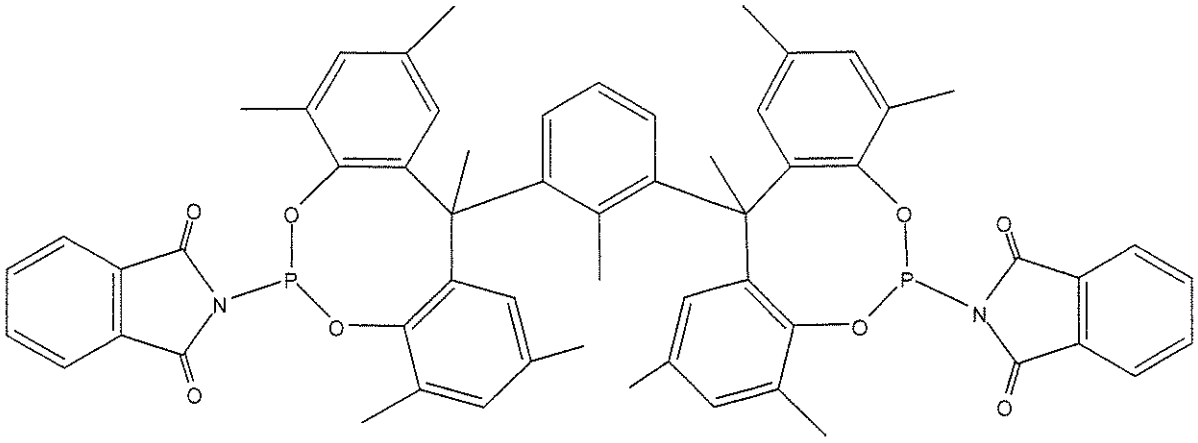
The organic phosphorus compounds claimed in these embodiments – also referred to as tetraphenol ligands or tetraphenol-substituted bisphosphites – are hereinbelow further disclosed and characterized in the preparation examples according to the ~~invention~~disclosure.

For clarity, the tetraphenol ligands claimed are referred to as TP1 to TP7 in the preparation examples according to the ~~invention~~disclosure. The structures belonging to the claimed tetraphenol ligands are likewise disclosed in scheme 1 in the preparation examples according to the ~~invention~~disclosure.

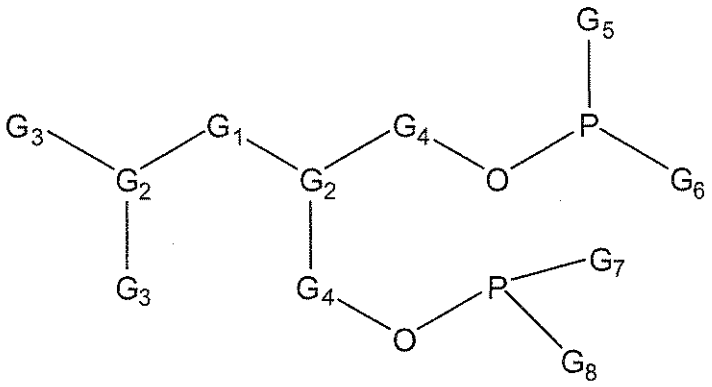
Further embodiments of formula 2 according to the ~~invention~~disclosure are recited by way of example in the following structure which is designated TP:



TP



The present ~~inventiondisclosure~~ also provides organic phosphorus compounds of formula 3



3

where:

O in each occurrence is an oxygen atom,

P in each occurrence is a phosphorus atom,

G1 is an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 by a monovalent bond in each case;

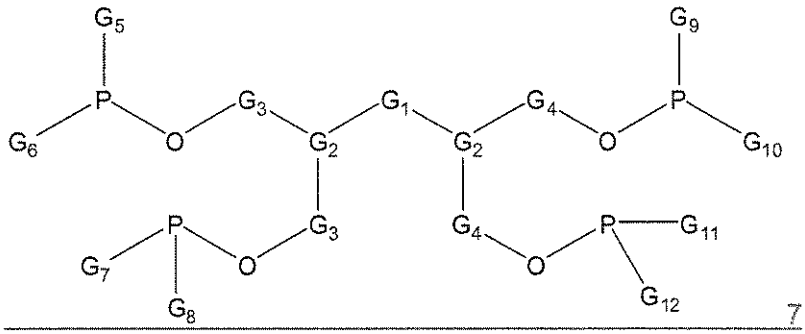
G2 is an alkyl radical and is connected to G1, G3 and/or G4 by a monovalent bond in each case;

G3 is in each case substituted by an OH group and is an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 by a monovalent bond in each case;

G4 is an at least monosubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 and O by a monovalent bond in each case;

G5, G6, G7 and G8 are each identical or different units or G5 paired with G6 and G7 paired with G8 are covalently linked units connected to P by monovalent bonds and selected from the group O-alkyl, O-aryl, O-acyl, O-heteroaryl, O-cycloalkyl, O-silyl, acyl, alkyl, aryl, heteroaryl, cycloalkyl, perfluoroalkyl, N-acyl, N-alkyl, N-aryl, N-heteroaryl, N-cycloalkyl, N-silyl.

In a third aspect, there is provided an organic phosphorus compound of formula 7



7

wherein:

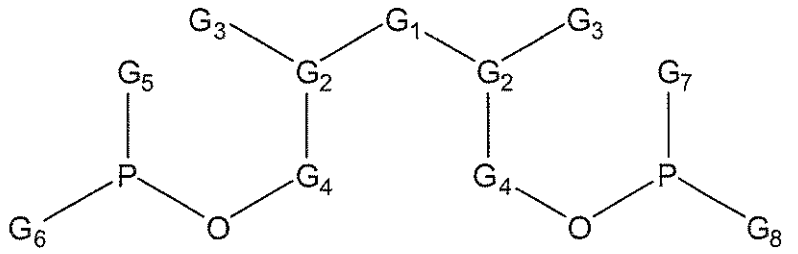
G1 is a 1,3-disubstituted phenylene radical;

G2 represents an alkyl radical which is bound monovalent to each G1, G3 and/or G4;

G3 and G4 are identical or different and at least a disubstituted cyclic structure selected out of the group of aromatic, heteroaromatic, fused aromatic or fused heteroaromatic systems containing arbitrary further substitution, which is bound monovalent to each G2 and O;

G5, G6, G7, G8, G9, G10, G11 and G12 are each identical or different monovalent units bound to P or G5 with each G6, G7 with each G8, G9 with each G10 and G11 with each G12 covalently linked and monovalent bound to P, selected from O-alkyl, O-aryl, O-acyl, O-heteroaryl, O-cycloalkyl, O-silyl, acyl, alkyl, aryl, heteroaryl, cycloalkyl, perfluoroalkyl, N-acyl, N-alkyl, N-aryl, N-heteroaryl, N-cycloalkyl, N-silyl.

The ~~invention~~disclosure further provides organic phosphorus compounds of formula 4

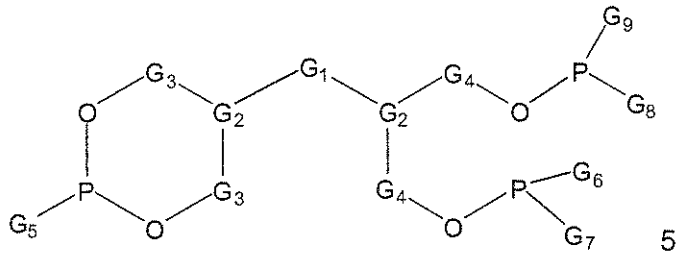


4

where:

O in each occurrence is an oxygen atom,
P in each occurrence is a phosphorus atom,
G1 is an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 by a monovalent bond in each case;
G2 is an alkyl radical and is connected to G1, G3 and/or G4 by a monovalent bond in each case;
G3 is in each case substituted by an OH group and is an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 by a monovalent bond in each case;
G4 is an at least monosubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 and O by a monovalent bond in each case;
G5, G6, G7 and G8 are each identical or different units or G5 paired with G6 and G7 paired with G8 are covalently linked units connected to P by monovalent bonds and selected from the group O-alkyl, O-aryl, O-acyl, O-heteroaryl, O-cycloalkyl, O-silyl, acyl, alkyl, aryl, heteroaryl, cycloalkyl, perfluoroalkyl, N-acyl, N-alkyl, N-aryl, N-heteroaryl, N-cycloalkyl, N-silyl.

The present ~~invention~~disclosure also provides organic phosphorus compounds of formula 5



5

where:

O in each occurrence is an oxygen atom,

P in each occurrence is a phosphorus atom,

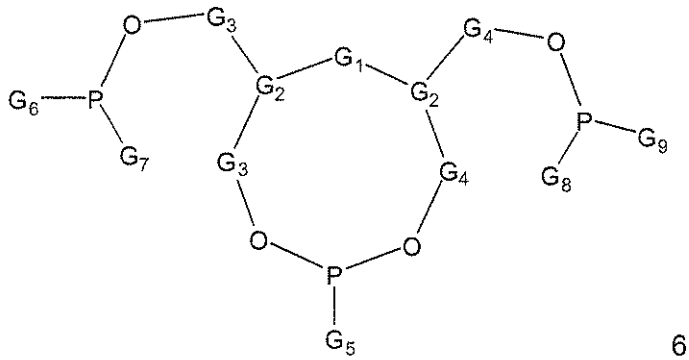
G1 is an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 by a monovalent bond in each case;

G2 is an alkyl radical and is connected to G1, G3 and/or G4 by a monovalent bond in each case;

G3 and G4 are the same or different and are each an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 and O by a monovalent bond in each case;

G5, G6, G7, G8 and G9 are each identical or different units or G6 paired with G7 and G8 paired with G9 are covalently linked units connected to P by monovalent bonds and selected from the group O-alkyl, O-aryl, O-acyl, O-heteroaryl, O-cycloalkyl, O-silyl, acyl, alkyl, aryl, heteroaryl, cycloalkyl, perfluoroalkyl, N-acyl, N-alkyl, N-aryl, N-heteroaryl, N-cycloalkyl, N-silyl.

The ~~invention~~disclosure further provides organic phosphorus compounds of formula 6



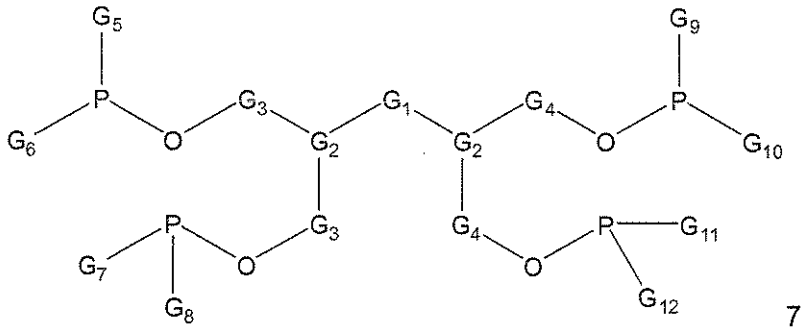
6

where:

O in each occurrence is an oxygen atom,

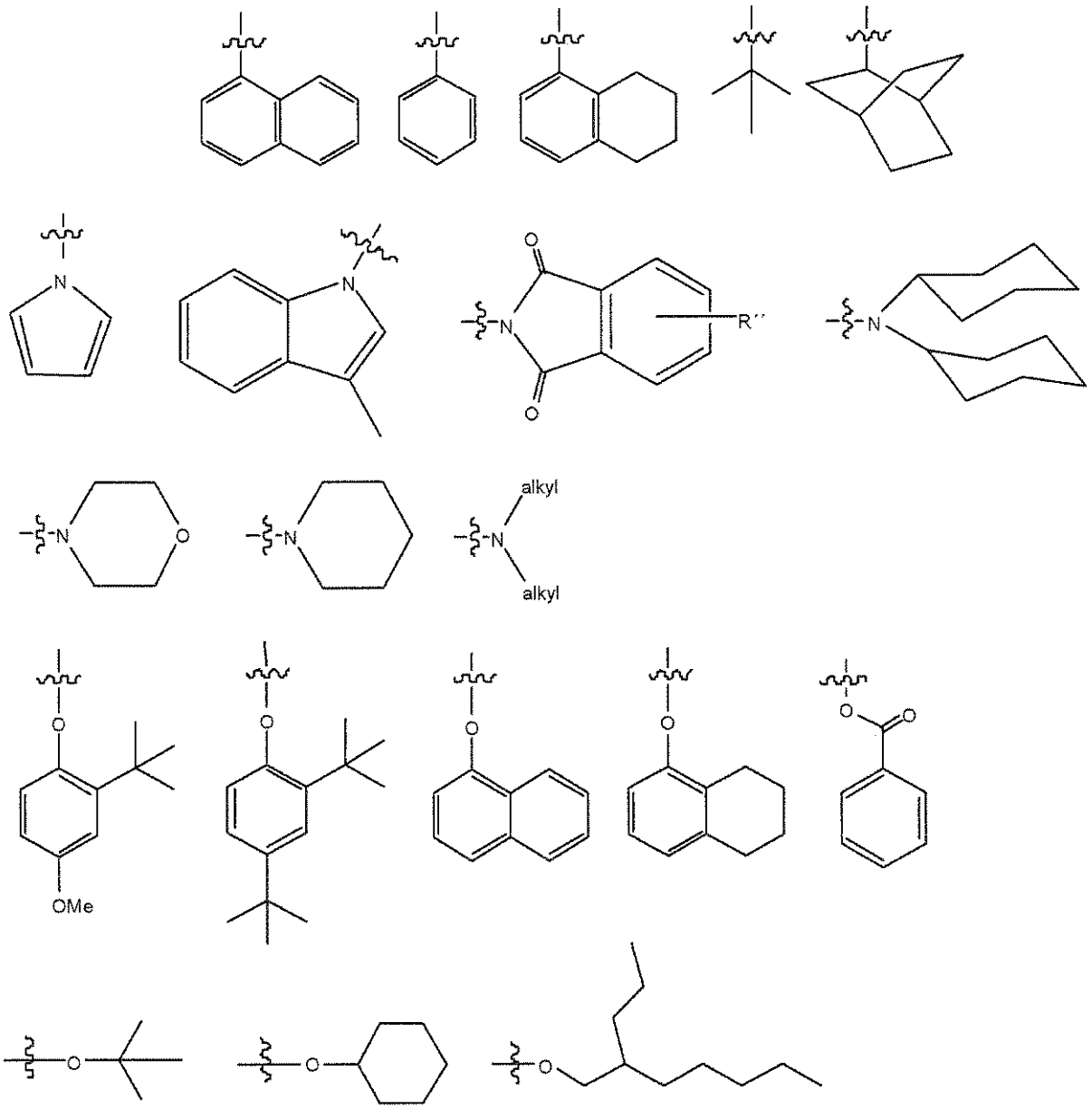
P in each occurrence is a phosphorus atom,
G1 is an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 by a monovalent bond in each case;
G2 is an alkyl radical and is connected to G1, G3 and/or G4 by a monovalent bond in each case;
G3 and G4 are the same or different and are each an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 and O by a monovalent bond in each case;
G5, G6, G7, G8 and G9 are each identical or different units or G6 paired with G7 and G8 paired with G9 are covalently linked units connected to P by monovalent bonds and selected from the group O-alkyl, O-aryl, O-acyl, O-heteroaryl, O-cycloalkyl, O-silyl, acyl, alkyl, aryl, heteroaryl, cycloalkyl, perfluoroalkyl, N-acyl, N-alkyl, N-aryl, N-heteroaryl, N-cycloalkyl, N-silyl.

The present ~~invention~~disclosure also provides organic phosphorus compounds of formula 7



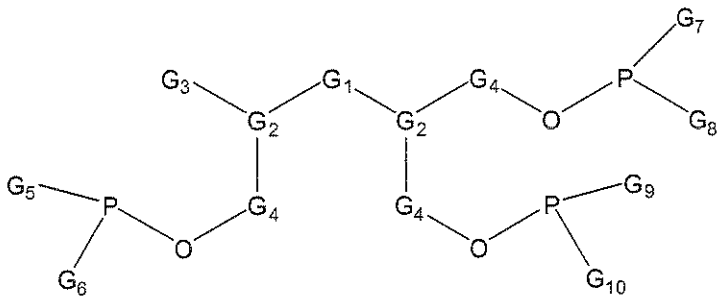
7

where:
O in each occurrence is an oxygen atom,
P in each occurrence is a phosphorus atom,
G1 is an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 by a monovalent bond in each case;
G2 is an alkyl radical and is connected to G1, G3 and/or G4 by a monovalent bond in each case;
G3 and G4 are the same or different and are each an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 and O by a monovalent bond in each case;



The representative of formula 40 where R = 2,4-di-tert-butylphenoxy is an embodiment claimed according to the ~~invention~~disclosure and constitutes a tetraphenol-based tetraphosphite, this embodiment being further disclosed, under the TP8 formula, in the preparation examples according to the ~~invention~~disclosure.

The ~~invention~~disclosure further provides organic phosphorus compounds of formula 8



8

where:

O in each occurrence is an oxygen atom,

P in each occurrence is a phosphorus atom,

G1 is an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 by a monovalent bond in each case;

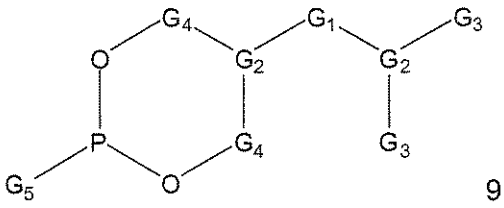
G2 is an alkyl radical and is connected to G1, G3 and/or G4 by a monovalent bond in each case;

G3 is in each case substituted by an OH group and is an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 by a monovalent bond;

G4 is an at least monosubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 and O by a monovalent bond in each case;

G5, G6, G7, G8, G9 and G10 are each identical or different units or G5 paired with G6, G7 paired with G8 and G9 paired with G10 are each covalently linked units connected to P by monovalent bonds and selected from the group O-alkyl, O-aryl, O-acyl, O-heteroaryl, O-cycloalkyl, O-silyl, acyl, alkyl, aryl, heteroaryl, cycloalkyl, perfluoroalkyl, N-acyl, N-alkyl, N-aryl, N-heteroaryl, N-cycloalkyl, N-silyl.

The present ~~invention~~disclosure also provides organic phosphorus compounds of formula 9



9

where:

O in each occurrence is an oxygen atom,

P in each occurrence is a phosphorus atom,

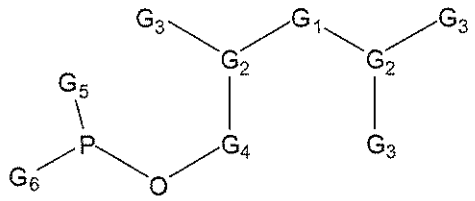
G1 is an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 by a monovalent bond in each case;

G2 is an alkyl radical and is connected to G1, G3 and/or G4 by a monovalent bond in each case;

G3 is in each case substituted by an OH group and is an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or

fused heteroaromatic systems with any desired further substitution, and connected to G2 by a monovalent bond;
G4 is an at least monosubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 and O by a monovalent bond in each case;
G5 is a unit linked to P by a monovalent bond and selected from the group O-alkyl, O-aryl, O-acyl, O-heteroaryl, O-cycloalkyl, O-silyl, acyl, alkyl, aryl, heteroaryl, cycloalkyl, perfluoroalkyl, N-acyl, N-alkyl, N-aryl, N-heteroaryl, N-cycloalkyl, N-silyl.

The ~~invention~~disclosure further provides organic phosphorus compounds of formula 10



10

where:
O in each occurrence is an oxygen atom,
P in each occurrence is a phosphorus atom,
G1 is an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 by a monovalent bond in each case;
G2 is an alkyl radical and is connected to G1, G3 and/or G4 by a monovalent bond in each case;
G3 is in each case substituted by an OH group and is an at least disubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 by a monovalent bond;
G4 is an at least monosubstituted cyclic structure selected from the group of aromatics, heteroaromatics, fused aromatics systems or fused heteroaromatic systems with any desired further substitution, and connected to G2 and O by a monovalent bond in each case;
G5 and G6 are each identical or different units or G5 paired with G6 are covalently linked units connected to P by monovalent bonds and selected from the group O-alkyl, O-aryl, O-acyl, O-heteroaryl, O-cycloalkyl, O-silyl, acyl, alkyl, aryl, heteroaryl, cycloalkyl, perfluoroalkyl, N-acyl, N-alkyl, N-aryl, N-heteroaryl, N-cycloalkyl, N-silyl.

In a fourth aspect, there is provided metal complexes, comprising a metal of group 4, 5, 6, 7, 8, 9 or 10 of the periodic table and one or more organic phosphorus compounds as defined above.

The ~~invention~~disclosure also provides metal complexes containing a metal of group 4, 5, 6, 7, 8, 9 or 10 of the periodic table and one or more organic phosphorus compounds which are recited as TP1, TP2, TP3, TP4 or TP5 in the preparation examples according to the ~~invention~~disclosure.

In a particular embodiment, the metal complexes according to the ~~invention~~disclosure are characterized in that the metal is rhodium, palladium, nickel, platinum, cobalt or ruthenium.

In a further embodiment, at least one of the organic phosphorus compounds referred to as TP1, TP2, TP3, TP4 or TP5 in the preparation examples according to the ~~invention~~disclosure and/or a metal complex based on rhodium, palladium, nickel, platinum, cobalt or ruthenium finds use in catalysis.

In a further embodiment, at least one of the organic phosphorus compounds referred to as TP1, TP2, TP3, TP4 or TP5 in the preparation examples according to the ~~invention~~disclosure and/or a metal complex based on rhodium, palladium, nickel, platinum, cobalt or ruthenium finds advantageous use in homogeneous catalysis.

In a very particular embodiment, at least one of the organic phosphorus compounds referred to as TP1, TP2, TP3, TP4 or TP5 in the preparation examples according to the ~~invention~~disclosure and/or a metal complex based on rhodium, palladium, nickel, platinum, cobalt or ruthenium finds use in a process for hydroformylation of olefin-containing mixtures.

The metal complexes claimed are further disclosed and characterized in the preparation examples according to the ~~invention~~disclosure.

In a fifth aspect, there is provided a process for hydroformylation of unsaturated hydrocarbon mixtures using a catalytic active composition, containing a transition metal of groups 8 to 10, wherein the catalytic active composition comprises an organic phosphorus compound as defined above.

The ~~invention~~disclosure also provides a process for hydrocyanation of pentenenitrile-containing streams using a catalytically active composition, characterized in that the catalytically active composition contains an organic phosphorus compound which is referred to as TP1, TP2, TP3, TP4 or TP5 in the preparation examples according to the ~~invention~~disclosure. Further details of the disclosure are found in the process examples according to the ~~invention~~disclosure.

A particular embodiment of the hydrocyanation process according to the ~~invention~~disclosure is characterized in that the hydrocyanation is effected by foreclosing any isomerization to branched nitriles. Further details of the disclosure are found in the process examples according to the ~~invention~~disclosure.

The ~~invention~~disclosure further provides a process for hydrocyanation of butadiene-containing streams using a catalytically active composition, characterized in that the catalytically active composition contains an organic phosphorus compound which is referred to as TP2 in the preparation examples according to the ~~invention~~disclosure.

A particular embodiment of the process for hydrocyanation of butadiene-containing streams is characterized in that butadiene is hydrocyanated to linear pentenenitriles with an n/iso selectivity of more than 99%. Further details of the disclosure are found in the process examples according to the ~~invention~~disclosure.

The ~~invention~~disclosure also provides a process for hydroformylation of unsaturated hydrocarbon mixtures using a catalytically active composition containing a transition metal of groups 8 to 10, characterized in that the catalytically active composition includes an organic phosphorus compound which is referred to as TP1, TP2, TP3, TP4 or TP5 in the preparation examples according to the ~~invention~~disclosure.

A particular embodiment of the process for hydroformylating unsaturated hydrocarbon mixtures which is in accordance with the ~~invention~~disclosure is characterized in that the catalytically active composition contains an organic phosphorus compound referred to as TP1, TP2, TP3, TP4 or TP5 in the preparation examples according to the ~~invention~~disclosure and rhodium. Further details of the disclosure are found in the process examples according to the ~~invention~~disclosure.

A further embodiment of the process for hydroformylating unsaturated hydrocarbon mixtures which is in accordance with the present ~~invention~~disclosure is characterized in that a stream containing olefins having at least 4 to 20 carbon atoms is used as unsaturated hydrocarbon mixture.
A preferable embodiment utilizes the following streams as unsaturated hydrocarbon mixture:

raffinate I in commercially available composition;
raffinate III in commercially available composition, containing a remainder of C4-alkanes, linear C4-alkenes and also isobutene and C5-alkanes;
so-called crude butane containing C4-alkanes, linear C4-alkenes and C5-alkanes;
so-called dibutene containing at least 98% by mass of C8-olefins, based on the total amount of C8-olefins, selected from the group of dimethylhexenes, methylheptenes and also n-octenes;
so-called tributenes containing a mixture of at least 98% by mass of C11- and C12-olefins, based on the total amount of C11- and C12-olefins.

Further details of the disclosure are found in the process examples according to the ~~invention~~disclosure.

The ~~invention~~disclosure further provides a process for hydroaminoalkylation of unsaturated hydrocarbon mixtures using a catalytically active composition containing a transition metal of groups 8 to 10, characterized in that the catalytically active composition includes an organic phosphorus compound referred to as TP6 in the preparation examples according to the ~~invention~~disclosure.

A particular embodiment of the hydroaminoalkylation process according to the ~~invention~~disclosure is characterized in that the catalytically active composition contains an organic phosphorus compound referred to as TP6 in the preparation examples according to the ~~invention~~disclosure and rhodium.

A further embodiment of the hydroaminoalkylation process according to the ~~invention~~disclosure is characterized in that the chemoselectivity concerning the product amine is above 90% and the formation of byproducts is below 10%. Further details of the disclosure are found in the process examples according to the ~~invention~~disclosure.

The ~~invention~~disclosure also provides a process for hydrogenation of unsaturated hydrocarbon mixtures using a catalytically active composition containing a transition metal of groups 8 to 10, characterized in that the catalytically active composition includes an organic phosphorus compound referred to as TP1 in the preparation examples according to the ~~invention~~disclosure. Further details of the disclosure are found in the process examples according to the ~~invention~~disclosure.

The ~~invention~~disclosure further provides a process for hydrosilylation of carbonyl compounds using a catalytically active composition containing a transition metal of groups 8 to 10, characterized in that the catalytically active composition includes an organic phosphorus compound referred to as TP3 in the preparation examples according to the ~~invention~~disclosure.
Further details of the disclosure are found in the process examples according to the ~~invention~~disclosure.

In a sixth aspect, there is provided the use of an organic phosphorus compound as defined above and/or a metal complex as defined above in catalysis.

In a seventh aspect, there is provided the use of an organic phosphorus compound as defined above and/or a metal complex as defined above in homogeneous catalysis.

In an eighth aspect, there is provided the use of an organic phosphorus compound as defined above and/or a metal complex as defined above in a process for hydro-formylation of olefinic mixtures.

Examples

The examples which follow illustrate the invention.