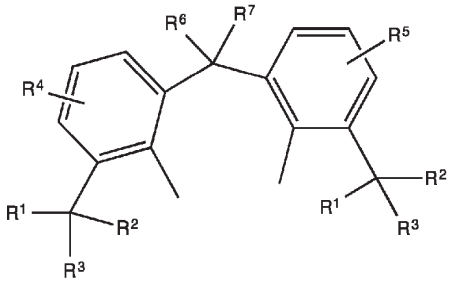
Claims

1. A catalyst composition comprising a transition metal (M) selected from Group VIIIB and rhenium, and a mixture of halophosphite conformational isomers A and B:



A **B**

the lone pair of electrons on the phosphorus atom in isomer A is in a pseudo-equatorial orientation;
the lone pair of electrons on the phosphorus atom in isomer B is in a pseudo-axial orientation;
X is fluorine or chlorine;
R is a divalent group having the formula 1:



1 ;

R^1, R^2, R^3, R^4, and R^5 are each independently hydrogen or a hydrocarbyl group containing 1 to 40 carbon atoms; and
R^6 and R^7 are each independently hydrogen or a hydrocarbyl group containing 1 to 10 carbon atoms with the proviso that at least one of R^6 and R^7 contains at least one carbon atom, and
wherein

(i) the molar ratio of B:A is such that the isomer B forms a complex with the transition metal, and
(ii) the molar ratio of A:M is 5 or less;

wherein the molar ratio of B:A is 20 or greater.

2. The catalyst composition according to claim 1, wherein the molar ratio of A:M is 4 or less.

3. The catalyst composition according to any of claims 1-2, wherein X is fluorine.

4. The catalyst composition according to any of claims 1-2, wherein R is a 2,2'-ethylidene bis(4,6-di-tert-butylphenyl) group.

5. The catalyst composition according to any of claims 1-2, wherein the transition metal comprises rhodium.

6. A catalyst solution comprising:

a) a hydroformylation solvent, and
b) a catalyst composition as defined in claim 1.

7. The catalyst solution according to claim 6, wherein the hydroformylation solvent is selected from alkanes, cycloalkanes, alkenes, cycloalkenes, carbocyclic aromatic compounds, esters, ketones, acetals, ethers, and water.

8. A process for preparing an aldehyde,
the process comprising contacting an olefin, hydrogen, and carbon monoxide with a catalyst solution at conditions effective to form an aldehyde, wherein the catalyst solution is defined in claim 6.

9. The process according to claim 8, wherein the concentration of rhodium in the catalyst solution is in the range of 20 to 300 mg/L, the molar ratio of halophosphite isomers to rhodium is at least 1:1, and the contacting step is carried out at a temperature of 50 to 135 °C and a pressure of ambient to 36 bars absolute.

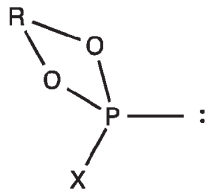
10. The process according to claim 8, wherein the olefin is a mono-α-olefin having 2 to 10 carbon atoms.

11. The process according to claim 10, wherein the olefin comprises propylene.

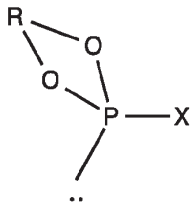
12. The process according to any of claims 8-11,
wherein the molar ratio of A:M is 4 or less; or
wherein X is fluorine; or
wherein R is a 2,2'-ethylidene bis(4,6-di-tert-butylphenyl) group; or
wherein the hydroformylation solvent is selected from alkanes, cycloalkanes, alkenes, cycloalkenes, carbocyclic aromatic compounds, esters, ketones, acetals, ethers, and water.

13. A method for separating conformational isomers, the method comprising:

(a) dissolving a feed mixture of halophosphite conformational isomers A and B in a solvent to form a reactant solution:



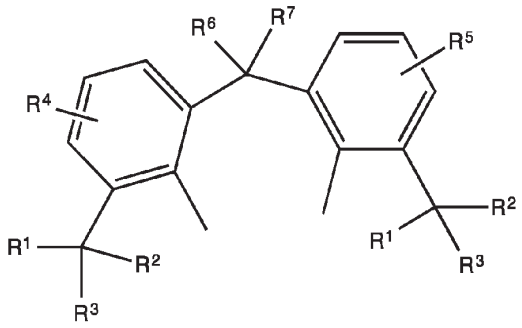
A



B

wherein

the lone pair of electrons on the phosphorus atom in isomer A is in a pseudo-equatorial orientation;
the lone pair of electrons on the phosphorus atom in isomer B is in a pseudo-axial orientation;
X is fluorine or chlorine;
R is a divalent group having the formula 1:



1 ;

R^1, R^2, R^3, R^4, and R^5 are each independently hydrogen or a hydrocarbyl group containing 1 to 40 carbon atoms; and

R^6 and R^7 are each independently hydrogen or a hydrocarbyl group containing 1 to 10 carbon atoms with the proviso that at least one of R^6 and R^7 contains at least one carbon atom;

(b) contacting the reactant solution with an alcohol in the presence of an acid catalyst at conditions effective to form a product mixture having a greater B:A molar ratio than the feed mixture; and
(c) quenching the product mixture with water.

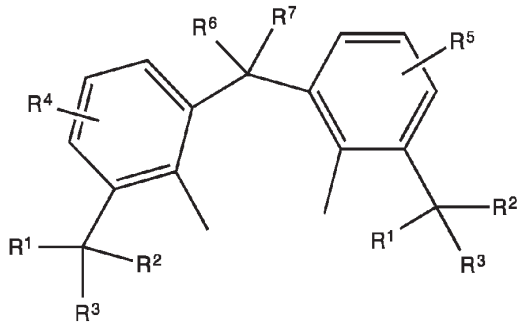
14. A composition comprising conformational isomers A and B:



A **B**

wherein

the lone pair of electrons on the phosphorus atom in isomer A is in a pseudo-equatorial orientation;
the lone pair of electrons on the phosphorus atom in isomer B is in a pseudo-axial orientation;
X is fluorine or chlorine;
R is a divalent group having the formula 1:



1 ;

R^1, R^2, R^3, R^4, and R^5 are each independently hydrogen or a hydrocarbyl group containing 1 to 40 carbon atoms; and
R^6 and R^7 are each independently hydrogen or a hydrocarbyl group containing 1 to 10 carbon atoms with the proviso that at least one of R^6 and R^7 contains at least one carbon atom;
and wherein the composition has a B:A molar ratio of greater than 1:1.

15. The composition according to claim 14, wherein the molar ratio of B:A is 20 or greater.