As well as the formation of the unwanted "*poisoning phosphites*", the phosphite ligand can also be degraded in the course of a hydrolysis reaction by the water traces formed in aldehyde condensation.

A consequence of these degradation reactions of the ligands is that the concentration of hydroformylation-active rhodium complex species decreases over the course of time and is accompanied by a loss of reactivity.

It is common knowledge that, in a continuous mode of hydroformylation, ligand(s) and optionally further components have to be replenished during the course of the reaction, i.e. have to be added additionally after commencement of the reaction (see DE 10 2008 002 187 A1).

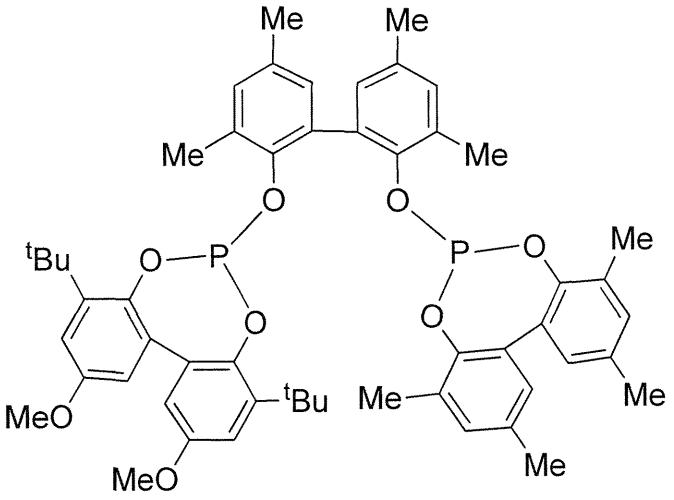
The technical object of the present invention is the provision of novel ligands which do not have the above-detailed disadvantages from the prior art in the hydroformylation of unsaturated compounds, but instead have the following properties:

1.) a high activity;
2.) a high n-regioselectivity in relation to the hydroformylation and
3.) a high service life.

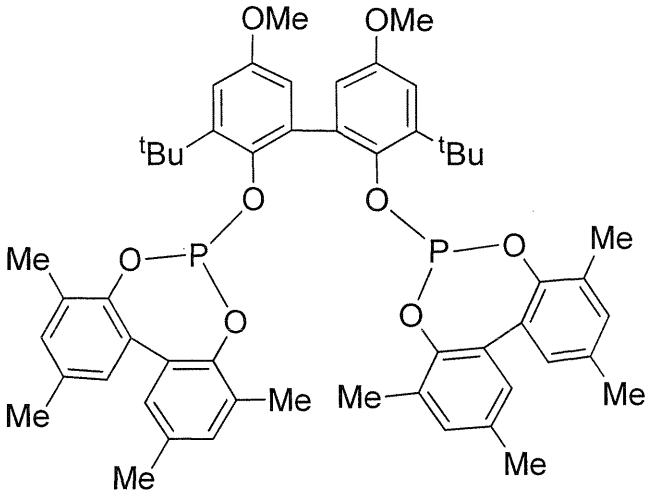
A high service life means that the hydroformylation-active composition comprising the ligands in addition to further components has a low tendency to degradation of these ligands and/or to decomposition of these ligands to hydroformylation-inhibiting components, for example the "*poisoning phosphites*".

Summary

In an aspect, there is provided a mixture of compounds of the formulae (1a) and (2a):



(1a)



(2a)

In another aspect, there is provided a process for preparing the mixture described herein, comprising the steps of:

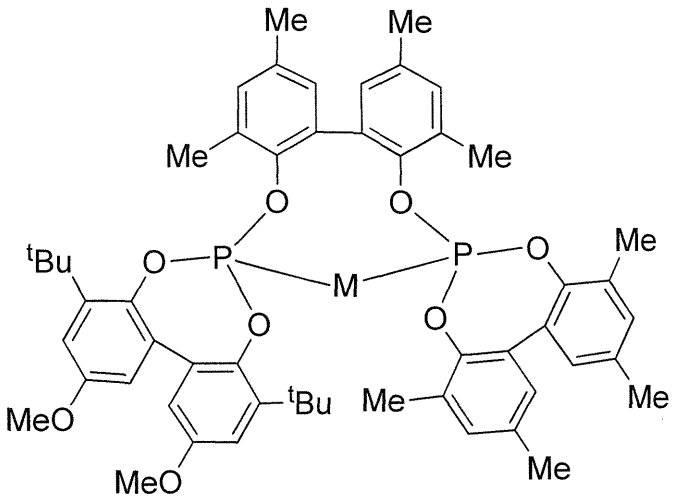
i) oxidatively coupling 2,4-dimethylphenol to give 3,3′,5,5′-tetramethyl-2,2′-dihydroxybiphenyl;

ii) oxidatively coupling 3-tert-butyl-4-hydroxyanisole to give 5,5′-dimethoxy-3,3′-di-tert-butyl-2,2′-dihydroxybiphenyl;

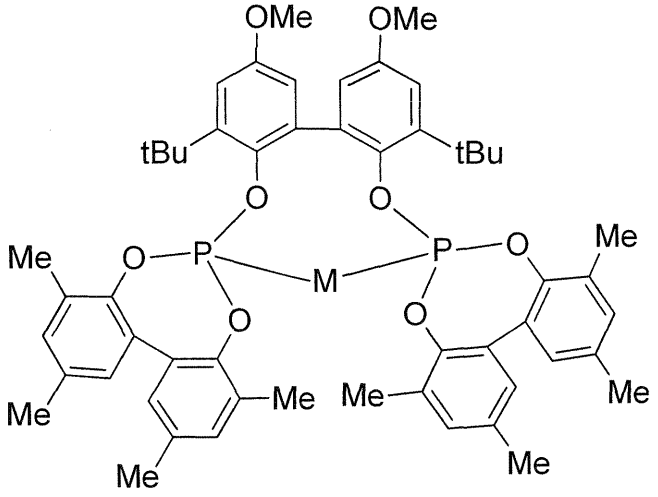
iii) reacting 3,3′,5,5′-tetramethyl-2,2′-dihydroxybiphenyl from i) with PCl_3 to give a phosphorochloridite derivative under inert gas atmosphere;

iv) reacting at least 2 equivalents of the phosphorochloridite derivative from iii) with 1 equivalent of the 5,5′-dimethoxy-3,3′-di-tert-butyl-2,2′-dihydroxybiphenyl from ii) under inert gas atmosphere.

In another aspect, there is provided a complex mixture of compounds of the formulae (1b) and (2b):



(1b)



(2b)

where each M is selected from Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, and M may enter into additional bonds.

In another aspect, there is provided a composition comprising:

- a complex mixture described herein,
- a further component selected from bases, organic amines, epoxides, buffer solutions, ion exchangers.

In another aspect, there is provided a process for hydroformylating an unsaturated compound or a mixture of unsaturated compounds, comprising the steps of:

a) initially charging a mixture or a composition described herein;

b) introducing a gas mixture comprising carbon monoxide and hydrogen;

c) adding at least one unsaturated compound or a mixture of unsaturated compounds.

The object is achieved by a mixture of the compounds of the formulae (1a) and (2a):