Claims

1. Process for hydroformylating C2 to C8 olefins in a reaction zone using a heterogenized catalyst system, wherein ~~the process is characterized in that~~

a gaseous feed mixture containing the C2 to C8 olefins is passed together with synthesis gas over a support composed of a porous ceramic material on which the catalyst system comprising a metal from group 8 or 9 of the Periodic Table of the Elements, at least one organic phosphorus-containing ligand, a stabilizer and optionally an ionic liquid is in heterogenized form; and

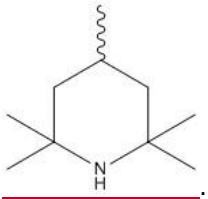
the support is in the form of a powder, in the form of a granular material or in the form of pellets and consists of a carbidic, nitridic or silicidic material or mixtures thereof, to which is applied a washcoat of the same or another ceramic material with respect to the ceramic material of the support.

wherein the organic phosphorus-containing ligand in the hydroformylation catalyst system has the general formula (VI)

R‘ – A – R‘‘ – A – R‘‘‘ (VI)

where R', R'' and R''' are each organic radicals, with the proviso that R’ and R’’’ are not identical, and each A is a bridging –O-P(-O)$_2$- group, where two of the three oxygen atoms -O- are each bonded to radical R’ and the radical R’’’, and

wherein the stabilizer is an organic amine compound containing at least one 2,2,6,6-tetramethylpiperidine unit of formula (I):



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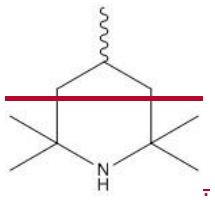
~~2. Process according to Claim 1, wherein the organic phosphorus-containing ligand in the hydroformylation catalyst system preferably has the general formula (VI)~~

~~R‘ – A – R‘‘ – A – R‘‘‘ (VI)~~

~~where R', R'' and R''' are each organic radicals, with the proviso that R' and R''' are not identical, and each A is a bridging –O-P(-O)$_2$- group, where two of the three oxygen atoms -O- are each bonded to radical R' and the radical R'''.~~

~~3. Process according to Claim 1 or 2, wherein the stabilizer is an organic amine compound containing at least one 2,2,6,6-tetramethylpiperidine unit of formula (I):~~



42. Process according to ~~any of~~ Claim~~s~~ 1 ~~to 3~~, wherein the nitridic ceramic is selected from silicon nitride, boron nitride, aluminium nitride and mixtures thereof; the carbidic ceramic is selected from silicon carbide, boron carbide, tungsten carbide or mixtures thereof; and the silicidic ceramic is molybdenum silicide.

53. Process according to Claim 42, wherein the support consists of a carbidic ceramic.

64. Process according to Claim 53, wherein the support consists of silicon carbide.

75. Process according to any of Claims 1 to 64, wherein the amount of the washcoat present on the support is ≤ 20% by weight, based on the total amount of support.

86. Process according to any of Claims 1 to 75, wherein the support has a median particle diameter (d50) of 0.1 mm to 7 mm.

97. Process according to any of Claims 1 to 86, wherein the hydroformylation is conducted at a temperature in the range from 65 to 200°C, preferably 75 to 175°C and more preferably 85 to 150°C.

~~10~~8. Process according to any of Claims 1 to ~~9~~7, wherein the pressure in the hydroformylation is not greater than 35 bar, preferably not greater than 30 bar, more preferably not greater than 25 bar.

~~11~~9. Process according to any of Claims 1 to ~~10~~8, wherein the catalyst system does not comprise any ionic liquid.