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

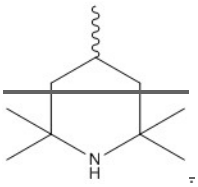
the support is a monolith, i.e. a block of a ceramic material, to which a washcoat composed of the same or a different ceramic material with respect to the ceramic material of the support is applied.

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 respectively bonded to the R' radical and the R''' radical.

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):



4. Process according to any of Claims 1 to 3, wherein the porous ceramic material of which the support consists is selected from the group consisting of a silicate ceramic, an oxidic ceramic, a nitridic ceramic, a carbidic ceramic, a silicidic ceramic and mixtures thereof.

5. Process according to Claim 4, wherein the silicate ceramic is selected from aluminosilicate, magnesium silicate, and mixtures thereof, for example bentonites; the oxidic ceramic is selected from γ-alumina, α-alumina, titanium dioxide, beryllium oxide, zirconium oxide, aluminium titanate, barium titanate, zinc oxide, iron oxides (ferrites) and mixtures thereof; 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.

6. Process according to Claim 4, wherein the porous ceramic material of which the support consists is a carbidic ceramic.

7. Process according to Claim 6, wherein the carbidic ceramic is selected from silicon carbide, boron carbide, tungsten carbide or mixtures thereof.

8. Process according to any of Claims 1 to 7, wherein the amount of washcoat present on the support is ≤ 20% by weight, based on the total amount of the support.

9. Process according to any of Claims 1 to 8, wherein the support composed of the ceramic material has one or more, preferably continuous, channels in main through-flow direction.

10. Process according to any of Claims 1 to 9, 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.

11. Process according to any of Claims 1 to 10, 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.

Claims

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

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

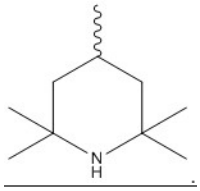
the support is a block of a ceramic material, to which a washcoat composed of the same or a different ceramic material with respect to the ceramic material of the support is applied.

2. The 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 respectively bonded to the R' radical and the R''' radical.

3. The process according to claim 1, 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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4. The process according to claim 1, wherein the porous ceramic material of which the support consists is selected from the group consisting of a silicate ceramic, an oxidic ceramic, a nitridic ceramic, a carbidic ceramic, a silicidic ceramic and mixtures thereof.

5. The process according to claim 4, wherein the silicate ceramic is selected from aluminosilicate, magnesium silicate, and mixtures thereof; the oxidic ceramic is selected from γ-alumina, α-alumina, titanium dioxide, beryllium oxide, zirconium oxide, aluminium titanate, barium titanate, zinc oxide, iron oxides (ferrites) and mixtures thereof; 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.

6. The process according to claim 4, wherein the porous ceramic material of which the support consists is a carbidic ceramic.

7. The process according to claim 6, wherein the carbidic ceramic is selected from silicon carbide, boron carbide, tungsten carbide or mixtures thereof.

8. The process according to claim 1, wherein the amount of washcoat present on the support is ≤20% by weight, based on the total amount of the support.

9. The process according to claim 1, wherein the support composed of the ceramic material has one or more channels in main through-flow direction.

10. The process according to claim 1, wherein the hydroformylation is conducted at a temperature in the range from 65 to 200° C.

11. The process according to claim 1, wherein the pressure in the hydroformylation is not greater than 35 bar.

12. The process according to claim 1, wherein the support composed of the ceramic material has one or more continuous channels in main through-flow direction.

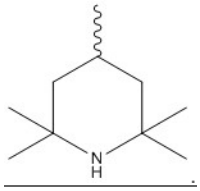
13. The process according to claim 1, wherein the hydroformylation is conducted at a temperature in the range from 75 to 175° C.

14. The process according to claim 1, wherein the hydroformylation is conducted at a temperature in the range from 85 to 150° C.

15. The process according to claim 1, wherein the pressure in the hydroformylation is not greater than 30 bar.

16. The process according to claim 1, wherein the pressure in the hydroformylation is not greater than 25 bar.

17. The process according to claim 2, wherein the stabilizer is an organic amine compound containing at least one 2,2,6,6-tetramethylpiperidine unit of formula (I):



18. The process according to claim 2, wherein the porous ceramic material of which the support consists is selected from the group consisting of a silicate ceramic, an oxidic ceramic, a nitridic ceramic, a carbidic ceramic, a silicidic ceramic and mixtures thereof.

19. The process according to claim 18, wherein the silicate ceramic is selected from aluminosilicate, magnesium silicate, and mixtures thereof; the oxidic ceramic is selected from γ-alumina, α-alumina, titanium dioxide, beryllium oxide, zirconium oxide, aluminium titanate, barium titanate, zinc oxide, iron oxides (ferrites) and mixtures thereof; 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.

20. The process according to claim 18, wherein the porous ceramic material of which the support consists is a carbidic ceramic.