Claims

1. A Pprocess for preparing a target alcohol, wherein the process comprises the following steps:

   a) preparing an ester by reacting (carbonylating) a C2 to C16 hydrocarbon having at least one multiple bondalkene or isoalkene with carbon monoxide and with an alcohol A, which is a mono- or polyalcohol (two or more OH groups) having 1 to 50 carbon atoms or is a mixture of two or more mono- and/or polyalcohols and which is used in a molar ratio to the C2 to C16 hydrocarbon alkene or isoalkene (alcohol:C2 to C16 hydrocarbonalkene or isoalkene) of 2 to 20, in the presence of a homogeneous catalyst system comprising at least one metal of groups 8 to 10 of the Periodic Table of the Elements or a compound thereof, a phosphorus-containing ligand and an acid, in a reaction zone to obtain a liquid product mixture, wherein the carbon monoxide is directly supplied or by a carbon monoxide-containing gas selected from the group consisting of synthesis gas, water gas, and generator gas;

   b) performing a membrane separation to separate the homogeneous catalyst system from the liquid product mixture, which enriches the homogeneous catalyst system and additionally unconverted hydrocarbon and/or unconverted alcohol A in the retentate and enriches the ester formed in step a) in the permeate, wherein the membrane material used is an OSN (organic solvent nanofiltration) membrane material which is acid-stable, i.e. stable in the presence of the acid of the catalyst system for at least 300 h, and which has at least one separation-active layer, and wherein the retentate is returned to the reaction zone in step a) and the permeate is routed to the subsequent step c);

   c) separating the ester formed in step a) from the permeate in at least one separation process step selected from the group consisting of thermal separation, for example distillation, extraction, crystallization and membrane separation;

   d) hydrogenating the ester separated in step c) with hydrogen in the presence of the heterogeneous catalyst system in a hydrogenation zone to obtain an alcohol mixture comprising at least the target alcohol, the eliminated alcohol A and unconverted esters;

   e) separating the target alcohol formed in step d) in at least one separation process step selected from thermal separation, for example distillation, extraction, crystallization and membrane separation.

2. The Pprocess according to Claim 1, wherein the separation-active layer is composed of a polyaryl ether ketone (PAEK) polymer.

3. The Pprocess according to Claim 2, wherein the separation-active layer is composed of polyether ether ketone (PEEK)~~, preferably~~ having a degree of sulfonation of less than 20%~~, particularly preferably less than 10%~~.

4. The Pprocess according to ~~any of the preceding claims~~Claim 1, wherein the alcohol A used in step a) is a mono- or polyalcohol (two or more OH groups) having from 1 to 15 carbon atoms, ~~more preferably 1 to 10 carbon atoms,~~ or a mixture of two or more mono- and/or polyalcohols.

5. The Pprocess according to Claim 4, wherein the alcohol A used in step a) is selected from the group consisting of methanol, ethanol, 1-propanol, 1-butanol, 1-pentanol, 1-hexanol, 2-propanol, tert-butanol, 3-pentanol, 2-propylheptanol, cyclohexanol, phenol and mixtures thereof.

6. The Pprocess according to ~~any of the preceding claims~~Claim 1, wherein the C2 to C16 hydrocarbon comprises ~~having~~ at least one olefinic double bond~~ which is used in step a) is an n- or isoalkene having 2 to 16 carbon atoms~~.

7. The Pprocess according to ~~any of the preceding claims~~Claim 1, wherein the metal of groups 8 to 10 of the Periodic Table of the Elements or a compound thereof in the homogeneous catalyst system in step a) is palladium or a compound thereof.

8. The Pprocess according to ~~any of the preceding claims~~Claim 1, wherein the phosphorus-containing ligand in the homogeneous catalyst system has a bidentate structure.

9. The Pprocess according to ~~any of the preceding claims~~Claim 1, wherein the reaction in step a) is conducted at a pressure of 5 to 60 bar.

10. The Pprocess according to ~~any of the preceding claims~~Claim 1, wherein the acid in the catalyst system in step a) is a Brønsted acid having a pKa ≤ 5, ~~preferably having a pKa ≤ 3,~~ or a Lewis acid having a~~n~~ Lewis acid unit (LAU) value of more than 25~~, preferably having an LAU value of 29~~.

11. The Pprocess according to ~~any of the preceding claims~~Claim 1, wherein the acid in the catalyst system in step a) is a Brønsted acid or a Lewis acid, where the Brønsted acid is

perchloric acid, sulfuric acid, phosphoric acid, methylphosphonic acid or a sulfonic acid, and where the Lewis acid is aluminium triflate, aluminium chloride, aluminium hydride, trimethylaluminium, tris(pentafluorophenyl)borane, boron trifluoride, boron trichloride or a mixture thereof.

12. The ~~P~~process according to ~~any of the preceding claims~~Claim 1, wherein the carbon monoxide-containing gas is the synthesis gas and is separated to obtain separated carbon monoxide and separated hydrogen upstream of the reaction zone and the carbon monoxide ~~separated~~ is routed to the reaction zone in step a) and the hydrogen separated to the hydrogenation zone in step d).

13. The process according to Claim 2, wherein the separation-active layer is composed of PEEK.

14. The process according to Claim 2, wherein the alcohol A used in step a) is a mono- or polyalcohol (two or more OH groups) having from 1 to 10 carbon atoms, or a mixture of two or more mono- and/or poly alcohols.

15. The process according to Claim 1, wherein the acid in the catalyst system in step a) is a Bronsted acid having a pKa ≤ 3, or a Lewis acid having an LAU value of more than 25.

16. The process according to Claim 2, wherein the C2 to C16 hydrocarbon having at least one olefinic double bond which is used in step a) is an n- or isoalkene having from 2 to 16 carbon atoms.

~~13. Process according to any of the preceding claims, wherein the process after the separation in step c) includes the following further steps:~~

~~c1) transesterifying the ester formed in step a) with a second alcohol B, where this second alcohol B differs from the alcohol used in step a), in a second reaction zone to obtain a second liquid product mixture comprising at least the ester with the second alcohol B, the eliminated first alcohol A and unconverted second alcohols B, where the second alcohol B is used in an equimolar amount or in excess;~~

~~c2) separating off the ester formed in step c1) and separating the remaining second liquid product mixture by thermal separation and/or by means of membrane separation and recycling the eliminated first alcohol into the first reaction zone, and recycling the unconverted second alcohol into the second reaction zone;~~

wherein the ester formed in step c1) is used in the hydrogenation in step d).

14. Process according to Claim 10 or 11, wherein the second alcohol used in step e) is a higher-boiling alcohol compared with the first alcohol.

15. Process according to any of Claims 10 to 12, wherein part of the eliminated first alcohol is already withdrawn from the second reaction zone and recycled into the first reaction zone.