Patent claims

1. Process for producing methyl methacrylate, comprising the following steps:

   A) producing methacrolein from propanal and formaldehyde and

   B) reacting the methacrolein obtained in step A) with methanol in an oxidative esterification reaction to give methyl methacrylate,

   characterized in that the two steps A) and B) are carried out in a continuous process and take place in a liquid phase at a pressure of from 2 to 100 bar, and step B) is carried out in the presence of a heterogeneous noble-metal-containing catalyst comprising metals and/or comprising metal oxides.

2. Process according to claim 1, characterized in that step A) is carried out in the presence of from 0.1 to 20 mol% of organic base and from 0.1 to 20 mol% of acid, based in each case on propanal.

3. Process according to claim 1 or 2, characterized in that step A) is carried out at a temperature of from 100 to 300 °C.

4. Process according to at least one of the preceding claims, characterized in that step A) is carried out at a pressure of from 5 to 100 bar.

5. Process according to at least one of the preceding claims, characterized in that the heterogeneous oxidation catalyst used according to step B) for the oxidative esterification reaction comprises one or more ultra-finely dispersed metals with an average particle size of < 20 nm selected from the group consisting of gold, palladium, ruthenium, rhodium and silver.

6. Process according to at least one of the preceding claims, characterized in that the heterogeneous oxidation catalyst used according to step B) for the oxidative esterification reaction comprises one or more members of the group consisting of lithium, sodium, potassium, calcium, magnesium, scandium, yttrium, lanthanum and other lanthanoids with atomic numbers from 58 to 71, silicon, titanium, zirconium, hafnium, vanadium, niobium, tantalum, chromium, molybdenum, tungsten, manganese, rhenium, iron, ruthenium, osmium, cobalt, rhodium, iridium, nickel, palladium, platinum, copper, silver, gold, zinc, cadmium, boron, aluminium, gallium, indium, thallium, germanium, tin, lead, antimony, bismuth, tellurium, these being respectively present in metallic and/or oxidized form.

7. Process according to at least one of the preceding claims, characterized in that the heterogeneous noble-metal-containing catalyst is applied on a support comprising a metal oxide.

8. Process according to at least one of claims 2 to 7, characterized in that the reaction of propanal with formaldehyde to give methacrolein according to step A) uses a secondary amine as organic base.

9. Process according to at least one of claims 2 to 8, characterized in that step A) uses at least one organic acid.

10. Process according to at least one of claims 2 to 9, characterized in that the molar ratio of acid to organic base is in the range from 20:1 to 1:20.

11. Process according to at least one of the preceding claims, characterized in that the reaction according to step A) is carried out with a residence time in the range from 0.1 to 300 seconds.

12. Process according to at least one of the preceding claims, characterized in that the reaction according to step B) is carried out with a pressure in the range from 2 to 50 bar.

13. Process according to at least one of the preceding claims, characterized in that the oxidative esterification reaction according to step B) is carried out with a temperature in the range from 10 to 200 °C.

14. Process according to at least one of the preceding claims, characterized in that the oxidative esterification reaction according to step B) takes place with a molar ratio of methanol to methacrolein in the range from 1:1 to 50:1.

15. Process according to at least one of the preceding claims, characterized in that the reactor volume in step A) is smaller than the reactor volume in step B) and the ratio of the two reactor volumes is in the range from 1:1000 to 1:100.

16. Process according to at least one of the preceding claims, characterized in that the total amount of separately added water in the two steps A) and B) during the conduct of the reaction is not greater than 100 mol%, based on methacrolein.

17. Process according to at least one of the preceding claims, characterized in that no water at all is separately added in the two steps A) and B) during the conduct of the reaction.