Claims

1. A process for removing polyunsaturated hydrocarbons from an olefin-containing C4 hydrocarbon stream that, in addition to C4 hydrocarbons, also contains C5 hydrocarbons in a range between 0.01 and 5% by weight and mercaptans and/or disulfides in a range between 0.01 and 200 ppm by weight,
wherein the process comprises a first step and a second step as follows:

in the first step, at least some of the polyunsaturated hydrocarbons from the olefin-containing C4 hydrocarbon stream are hydrogenated and reacted with the mercaptans and/or disulfides from the olefin-containing C4 hydrocarbon stream in a first reaction zone in a presence of a molar ratio of hydrogen to polyunsaturated hydrocarbons between 0.01 and 0.8,
wherein the first reaction zone consists of one or more reactors connected in parallel and/or in series,
wherein the first step is carried out using a first catalyst comprising an alumina support material and a metal, wherein the metal comprises a combination of palladium and platinum having a palladium concentration of up to 2.0% by weight and a platinum concentration of up to 1.0% by weight,
wherein the concentration of the palladium is at least a factor of 2 higher than that of platinum,
wherein no carbon monoxide is added to the C4 hydrocarbon stream in the first step, and
wherein not more than 80 mol% of the available polyunsaturated hydrocarbons from the C4 hydrocarbon stream are hydrogenated and reacted in the first step; and

in the second step, remaining polyunsaturated hydrocarbons in the olefin-containing C4 hydrocarbon stream are selectively hydrogenated using a second catalyst in the presence of hydrogen and carbon monoxide in a second reaction zone, which consists of one or more reactors connected in parallel and/or in series,
wherein the second catalyst contains only a single metal of the 10th group of the periodic table, wherein the single metal is palladium; and

wherein at least one removal of high boilers takes place between the first step and the second step.

2. The process according to Claim 1, wherein the molar ratio of hydrogen to polyunsaturated hydrocarbons in the first step is between 0.1 and 0.5.

3. The process according to Claim 1 or 2, wherein an inlet temperature of the C4 hydrocarbon stream in an inflow of the first reaction zone is between 0°C and 180°C, preferably between 60°C and 150°C, more preferably between 80°C and 130°C.

4. The process according to any of Claims 1 to 3, wherein the first step is carried out in a liquid phase and the hydrogen present has been dissolved in the liquid phase.

5. The process according to any of Claims 1 to 4, wherein, in the second step, the content of carbon monoxide in the C4 hydrocarbon stream in an inflow of the second reaction zone is 0.05 to 20 ppm based on a total amount of the hydrocarbon stream.

6. The process according to any of Claims 1 to 5, wherein an inlet temperature of the C4 hydrocarbon stream in an inflow of the second reaction zone, is between 0°C and 100°C, preferably between 20°C and 80°C, more preferably between 30°C and 60°C.

7. The process according to any of Claims 1 to 6, wherein a pressure in the second reaction zone, is in the range from 2 to 50 bar, preferably in the range from 6 to 30 bar, more preferably in the range from 10 to 25 bar.

8. The process according to any of Claims 1 to 7, wherein the second step is carried out exclusively in a liquid phase.

9. The process according to any of Claims 1 to 8, wherein the first reaction zone consists of a single reactor.

10. The process according to any of Claims 1 to 9, wherein the second reaction zone consists of at least two reactors connected in parallel or in series.

11. The process according to any one of claims 1 to 10, wherein the at least one removal of high boilers is done with a distillation column having 40 to 100 theoretical plates and the distillation column has a reflux ratio of between 1 and 2.5

12. The process according to any one of claims 1 to 11, wherein the first catalyst comprises a palladium concentration of up to 1.0% by weight and a platinum concentration of up to 0.5% by weight.

13. The process according to any one of claims 1 to 12, wherein the first catalyst comprises a palladium concentration of up to 0.5% by weight and a platinum concentration of up to 0.2% by weight.

14. The process according to any one of claims 1 to 13, wherein the first catalyst comprises a palladium concentration of 0.5% by weight and a platinum concentration of 0.2% by weight.

15. The process according to any one of claims 1 to 14, wherein the C4 hydrocarbon stream contains mercaptans.

16. The process according to any one of claims 1 to 14, wherein the C4 hydrocarbon stream contains disulfides.

17. The process according to any one of claims 1 to 14, wherein the C4 hydrocarbon stream contains mercaptans and disulfides.

18. The process according to any one of claims 1 to 17, wherein the metal consists of the combination of palladium and platinum.

19. The process according to any one of claims 1 to 18, wherein between the first and second step, at least some of the C5 hydrocarbons are removed from the C4 hydrocarbon stream.