Claims

1. A process for the regeneration of an adsorber comprising the following steps a) to c):

a) hydrogenation of a stream (S1) comprising at least one alkane and at least one olefin to obtain a liquid stream (S2) comprising at least one alkane and a reduced amount of at least one olefin compared to the amount in the stream (S1),

b) converting the stream (S2) from liquid phase into gaseous phase and

c) regenerating the adsorber by contact with the gaseous stream (S2) obtained in step b).

2. The process according to claim 1, wherein the stream (S1) comprises at least one alkane and at least one olefin in a total of at least 99 wt-%.

3. The process according to claim 2, wherein the at least one alkane and at least one olefin in the stream (S1) total at least 99.5 wt-%.

4. The process according to claim 2, wherein the at least one alkane and at least one olefin in the stream (S1) total at least 99.9 wt-%.

5. The process according to claim 1 or claim 2, wherein in step a),

i) the stream (S1) comprises butane and butene, and/or

ii) the amount of olefins containing more than one olefinic double bond in stream (S1) is lower than 500 ppm, and/or

iii) the stream (S2) comprises not more than 1000 wt-ppm olefin, and/or

iv) the stream (S2) comprises at least 99 wt-% of at least one alkane.

6. The process according to claim 5, wherein the stream (S1) comprises butane and butene in an amount of at least 96 wt-% butane and not more than 4 wt-% butene.

7. The process according to claim 5 or claim 6, wherein the amount of olefins containing more than one olefinic double bond in stream (S1) is lower than 300 ppm.

8. The process according to claim 5 or claim 6, wherein the amount of olefins

containing more than one olefinic double bond in stream (S1) is lower than 100 ppm.

9. The process according to any one of claims 5 to 8, wherein the olefin containing more than one olefinic double bond is a diene.

10. The process according to claim 9, wherein the olefin is butadiene.

11. The process according to any one of claims 5 to 10, wherein the stream (S2) comprises not more than 500 wt-ppm olefin.

12. The process according to any one of claims 5 to 10, wherein the stream (S2) comprises not more than 100 wt.-ppm olefin.

13. The process according to any one of claims 5 to 10 or claim 11 or claim 12, wherein olefin in stream (S2) is butene.

14. The process according to any one of claims 5 to 13, wherein the stream (S2) comprises at least 99.5 wt-% of the at least one alkane.

15. The process according to any one of claims 5 to 13, wherein the stream (S2) comprises at least 99.9 wt-% of the at least one alkane.

16. The process according to any one of claims 5 to 13 or claim 14 or claim 15, wherein the at least one alkane is butane.

17. The process according to any of claims 1 to 16, wherein the absorbent in the adsorber is based on aluminium oxide and/or the absorber can be employed for the adsorption of compounds containing oxygen and/or sulphur out of organic compositions.

18. The process according to claim 17, wherein the absorber can be employed for the adsorption of ethers, alcohols, thiols, thioethers, sulfoxides, ketones, aldehydes, or mixtures thereof.

19. The process according to claims 1 to 18, wherein in step b) the conversion is carried out by lowering the pressure and/or heating of the liquid stream (S2).

20. The process according to claim 19, wherein in step b) the conversion is carried out by employing at least one evaporator and/or at least one superheater and/or at least one flash vessel.

21. The process according to any of claims 1 to 20, wherein in step c) the regeneration of the adsorber is carried out at a temperature in the range of 230 to 270°C, and/or by passing the gaseous stream (S2) through a device containing the adsorber.

22. The process according to claim 21, wherein in step c) the regeneration of the adsorber is carried out at a temperature of 250°C.

23. The process according to any of claims 1 to 22, wherein prior to carrying out step c) a draining step d) is carried out in order to at least partially remove an organic composition which was passed through the adsorber during its operation mode.

24. The process according to any of claims 1 to 23, wherein step c) comprises at least one of the following component steps c1) to c5):

c1) heating the adsorber by contact with the gaseous stream (S2), wherein the gaseous stream (S2) is condensed within the adsorber,

c2) heating the adsorber by contact with the gaseous stream (S2) up to a temperature in the range of 230 to 270°C without any condensation of the gaseous stream (S2) within the adsorber,

c3) regeneration of the absorber at a temperature in the range of 230 to 270°C by contact with the gaseous stream (S2),

c4) cooling of the absorber by contact with the gaseous stream (S2) to a temperature in the range of 80-120°C, and/or

c5) cooling of the absorber by contact with the liquid stream (S2) obtained in step a) to a temperature below 80°C.

25. The process according to claim 24, wherein in c5) the absorber is cooled to a temperature in the range of 40 to 60°C.

26. The process according to claim 24 or claim 25, wherein step d) is carried out prior to step c) and step c) comprises the component steps c1), followed by c2), followed by c3), followed by c4) and followed by c5).

27. The process according to any one of claims 24 to 26, wherein the condensate obtained in step c1) contains the stream (S2) and the residue of the organic composition which was not removed from the adsorber when carrying out draining step d).

28. The process according to claim 27, wherein the condensate is collected in a device, in order to pass the collected condensate through an adsorber during its operation mode.

29. The process according to claim 27 or claim 28, wherein the device is a buffer vessel.

30. The process according to any one of claims 24 or 29, wherein the flow direction of the gaseous stream (S2) through the adsorber in steps c1), c2) and/or c3) is opposite to the flow direction of any organic composition through the same adsorber during its operation mode, and/or the gaseous stream (S2) in step c4) and/or the liquid stream (S2) in step c5) have the same flow direction through the adsorber as the flow direction of any organic composition through the same adsorber during its operation mode.

31. The process according to any of claims 1 to 30, wherein

i) the heating rate of the adsorber does not exceed 60°C/h, and/or

ii) the temperature of the gaseous stream (S2) is not more than 100°C, higher than the temperature of the adsorber, especially during the heating steps c1) and/or c2), and/or

iii) the temperature of the gaseous stream (S2) is not more than 100°C, lower than the temperature of the adsorber, especially during the cooling steps c4) and/or c5).

32. The process according to claim 31, wherein the heating rate of the adsorber does not exceed 40°C/h.

33. The process according to claim 31 or claim 32, wherein the temperature of the gaseous stream (S2) is not more than 60°C, higher than the temperature of the adsorber, especially during the heating steps c1) and/or c2).

34. The process according to any one of claims 31 to 33, wherein the temperature of the liquid stream (S2) is not more than 100°C, lower than the temperature of the adsorber, especially during the cooling steps c4) and/or c5).

35. The process according to any one of claims 31 to 33, wherein the temperature of the liquid stream (S2) is not more than 60°C, lower than the temperature of the adsorber, especially during the cooling steps c4) and/or c5).

36. The process according to any of claims 1 to 35, wherein

i) subsequent to step c), the outflow obtained from the absorber, comprising gaseous stream (S2) and the impurities removed from the adsorber, is condensed, and/or

ii) after finishing the regeneration of the adsorber according to step c), the adsorber is switched into its operation mode by feeding it with an organic composition to be purified.

37. The process according to claim 36, wherein the outflow is condensed by employing at least one condenser and/or at least one cooler.

38. The process according to any of claims 1 to 37, wherein the adsorber to be regenerated in step c) is part of an assembly which contains at least one further adsorber.

39. The process according to claim 38, wherein the at least one further adsorber is under its operation mode during the regeneration of the first adsorber, and/or each adsorber within this assembly is identical in respect of the adsorbent and its operation mode.

40. The process according to any of claims 1 to 39, wherein the stream (S1) originates from an organic composition which has been earlier purified by the same adsorber or by a similar further adsorber during the operation mode of the respective adsorber.

41. The process according to claim 40, wherein an oligomerization of olefins, and/or a distillation step to separate butane from butene is carried out prior to step a) and after the purification of the organic composition employing at least one adsorber in its operation mode.

42. The process according to claim 41, wherein the oligomerization of olefins, comprises a dimerization of butene to octene.