Claims

1. A process for the regeneration of an adsorber (A1) comprising the following steps a) to d):

a) regenerating the adsorber (A1) by contact with a gaseous stream (S2) comprising at least one alkane,

b) collecting the outflow of the adsorber (A1) in a device (D1), wherein the outflow comprises condensate of stream (S2) and an organic composition (OC1) comprising at least one olefin, at least one alkane and optionally at least one compound containing oxygen and/or sulphur,

c) replacing the stream (S2) in the adsorber (A1) completely or at least partially by the content of the device (D1), and

d) feeding the adsorber (A1) with an organic composition (OC2) comprising at least one olefin, at least one alkane and at least one compound containing oxygen and/or sulfur.

2. The process according to claim 1, comprising the further steps e) and/or f):

e) hydrogenation of a stream (S1) comprising at least one alkane and at least one olefin, carried out prior to step a), to obtain a liquid or gaseous stream (S2), and/or

f) converting, prior to step a), the liquid stream (S2) into gaseous phase.

3. The process according to claim 1 or 2, wherein

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

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

iii) the stream (S2) comprises at least 99 wt-% of at least one alkane, and/or

iv) the organic composition (OC2) in step d) comprises not more than 1000 wt-ppm of compounds containing oxygen and/or sulphur, and/or

v) the load of the adsorber (A1) with organic composition (OC2) in step d) is increased gradually and/or

vi) the organic composition (OC2) is routed through the device (D1) before being fed into the adsorber (A1) according to step d).

4. The process according to claim 3, wherein in step e), the stream (S1) comprises

butane and butene, with at least 96 wt-% butane and not more than 4 wt-% butene.

5. The process according to claim 3 or claim 4, wherein the stream (S2) comprises not more than 500 wt-ppm olefin.

6. The process according to claim 3 or claim 4, wherein the stream (S2) comprises not more than 100 wt-ppm olefin.

7. The process according to any one of claims 3 to 6, wherein the olefin is butene.

8. The process according to any one of claims 3 to 7, wherein the stream (S2) comprises at least 99.5 wt-% of the at least one alkane.

9. The process according to any one of claims 3 to 7, wherein the stream (S2) comprises at least 99.9 wt-% of the at least one alkane.

10. The process according to any one of claims 3 to 9, wherein the alkane is butane.

11. The process according to any one of claims 3 to 10, wherein the stream (S1) originates from the organic composition (OC2) which has been purified earlier by the same adsorber (A1) or by a similar further adsorber during the operation mode of the respective adsorber.

12. The process according to claim 11, wherein an oligomerization of olefins, and/or a distillation step to separate butane from butene is carried out prior to step e) and after the purification of the organic composition (OC2) employing at least one adsorber in its operation mode.

13. The process according to claim 12, wherein the oligomerization of olefins, involves a dimerization of butene to octene.

14. The process according to any one of claims 1 to 13, wherein prior to carrying out step a) a draining step g) is carried out in order to at least partially remove an organic composition (OC1) which was purified by the adsorber (A1) during its operation mode,

optionally the organic composition (OC1) obtained in the draining step g) is collected in a device (D1).

15. The process according to any one of claims 1 to 14, wherein step a) comprises component step a1) and at least one of the further following component steps a2) to a5):

a1) heating the adsorber (A1) by contact with the gaseous stream (S2), wherein the gaseous stream (S2) is condensed within the adsorber (A1),

a2) heating the adsorber (A1) 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 (A1),

a3) regeneration of the absorber (A1) at a temperature in the range of 230 to 270°C by contact with the gaseous stream (S2),

a4) cooling of the adsorber (A1) by contact with stream (S2) in gaseous state, to a temperature in the range of 80°C to 120°C, and/or

a5) cooling of the adsorber (A1) by contact with stream (S2) in liquid state to a temperature below 80°C.

16. The process according to claim 15, wherein the adsorber (A1) is cooled by contact with stream (S2) in liquid state to a temperature in the range of 40 to 60°C.

17. The process according to claim 15 or claim 16, wherein step g) is carried out prior to step a).

18. The process according to claim 17, wherein step b) is carried out at the same time as step a) and step a) comprises the component steps a1), followed by a2), followed by a3) followed by step a4) followed by a5).

19. The process according to claim 15, wherein the flow direction of the gaseous stream (S2) through the adsorber (A1) in steps a1), a2), a3) and/or b) is opposite to the flow direction of any organic composition through the same adsorber (A1) during its operation mode, and/or the gaseous stream (S2) in step a4) and/or the liquid stream (S2) in step a5) have the same flow direction through the adsorber (A1) as the flow direction of any organic composition through the same adsorber (A1) during its operation mode.

20. The process according to any one of claims 1 to 19, wherein the absorber (A1) is based on aluminium oxide and/or the absorber (A1) can be employed for the adsorption of compounds containing oxygen and/or sulphur out of organic compositions.

21. The process according to claim 20, wherein the absorber (A1) can be employed for the adsorption of ethers, alcohols, thiols, thioethers, sulfoxides, ketones, aldehydes or mixtures thereof.

22. The process according to claim 2, wherein in step f) the conversion is carried out by lowering the pressure and/or heating of the liquid stream (S2).

23. The process according to claim 22, wherein the conversion is carried out by employing at least one evaporator (EV1) and/or at least one super-heater (SH1) and/or at least one flash vessel (FV1).

24. The process according to any one of claims 1 to 23, wherein

the heating rate of the adsorber (A1) does not exceed 60°C/h, and/or

the temperature of the gaseous stream (S2) is not more than 100°C, higher than the temperature of adsorber (A1), especially during the heating steps a1), a2) and/or b), and/or

the temperature of the gaseous stream (S2) is not more than 100°C, lower than the temperature of the adsorber (A1), especially during the cooling steps a4) and/or a5).

25. The process according to claim 24, wherein the heating rate of the adsorber (A1) does not exceed 40°C/h.

26. The process according to claim 24 or claim 25, wherein the temperature of the gaseous stream (S2) is not more than 60°C, higher than the temperature of adsorber (A1), especially during the heating steps a1), a2) and/or b).

27. The process according to any one of claims 24 to 26, wherein the temperature of the gaseous stream (S2) is not more than 60°C, lower than the temperature of the adsorber (A1), especially during the cooling steps a4) and/or a5).

28. The process according to any one of claims 24 to 27, wherein the temperature of the liquid stream (S2) is not more than 100°C, lower than the temperature of the adsorber (A1), especially during the cooling steps a4) and/or a5).

29. The process according to any one of claims 24 to 27, wherein the temperature of the liquid stream (S2) is not more than 60°C, lower than the temperature of the adsorber (A1), especially during the cooling steps a4) and/or a5).

30. The process according to any one of claims 1 to 29, wherein in step a), the outflow obtained from the absorber (A1), comprising gaseous stream (S2) and the impurities removed from the adsorber (A1) is condensed at least partially.

31. The process according to claim 30, wherein in step a), the outflow obtained from the absorber (A1), comprising gaseous stream (S2) and the impurities removed from the adsorber (A1) is condensed at least partially, by employing at least one condenser and/or at least one cooler.

32. The process according to any one of claims 1 to 31, wherein the adsorber (A1) to be regenerated in step a) and b) is part of an assembly which contains at least one further adsorber (A2), and/or each adsorber within this assembly is identical in respect of the adsorbent and/or its mode of operation.

33. The process according to 32, wherein the at least one further adsorber (A2) is under its operation mode during the regeneration of the first adsorber (A1).

34. The process according to claim 32, wherein the at least one further adsorber (A2) is in operation mode and

i) in step d) the load of the further adsorber (A2) with organic composition (OC2) is gradually decreased at the same rate as the load of the first adsorber (A1) with organic composition (OC2) according to step d) is gradually increased, and/or

ii) in step d) the first adsorber (A1) and the at least one further adsorber (A2) are run with identical loads of organic composition (OC2) according to step d), then the at least one further adsorber (A2) is switched to regeneration mode.

35. The process according to any one of claims 1 to 34, wherein

i) in step c), if stream (S2) and organic composition (OC1) form at least two separated compositions and/or phases, the composition and/or phase in the device (D1) with the higher content of organic composition (OC1) is the content of the device (D1) in step c) replacing the stream (S2) in the adsorber (A1), and/or

ii) the part of stream (S2) in the adsorber (A1) which is replaced in the adsorber (A1) by a part of content of the device (D1) in step c) is collected in the device (D1).