

Claims

1. A process for the regeneration of an adsorber (A) comprising the following steps a) to d):
 - a) heating of a stream (S1) in at least two heat exchange units (HEU1) and (HEU2) to obtain a gaseous stream (S1) and a liquid stream (S1),
 - b) regeneration of the adsorber (A) by contact with the gaseous stream (S1) and the liquid stream (S1) obtaining, as the outflow of the adsorber (A), a stream (S2),
 - c) passing the stream (S2) through the heat exchange unit (HEU2), wherein the temperature of stream (S2) fed into the heat exchange unit (HEU2) is higher than the temperature of stream (S1) fed into the heat exchange unit (HEU2) in order to transfer heat from stream (S2) to stream (S1),
 - d) passing the stream (S2) through the heat exchange unit (HEU1), wherein the temperature of stream (S2) fed into the heat exchange unit (HEU1) is higher than the temperature of the stream (S1) fed into the heat exchange unit (HEU1) in order to transfer heat from stream (S2) to stream (S1), wherein
 - i) step c) and d) may be run in parallel by splitting stream (S2) into two parts,
 - ii) step c) is followed by step d) and the temperature of stream (S2) fed into the heat exchange unit (HEU2) is higher or equal than its temperature when being fed into heat exchange unit (HEU1) and/or
 - iii) temporarily only one of the steps c) and d) is carried out
- and wherein regeneration of the adsorber in step b) comprises at least one of the following component steps b1) to b5):
 - b1) heating the adsorber (A) by contact with the gaseous stream (S1), wherein the gaseous stream (S1) is condensed within the adsorber,
 - b2) heating the adsorber (A) by contact with the gaseous stream (S1) up to a temperature in the range of 230 to 270°C without any condensation of the gaseous stream (S1) within the adsorber,

b3) regeneration of the absorber (A) at a temperature in the range of 230 to 270°C by contact with the gaseous stream (S1),

5 b4) cooling of the absorber by contact with the gaseous stream (S1), and

b5) cooling of the absorber (A) by contact with the liquid stream (S1) to a temperature below 80°C, preferably to a temperature in the range of 40 to 60°C,

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and in step b), step b1) is followed by b2), followed by b3), followed by b4) and followed by b5) and the heating of the adsorber does not exceed 60°C/h and the temperature of the gaseous stream (S1) is not more than 100°C, higher than the adsorber (A), especially during the heating step b1) and/or b2) and the temperature of the gaseous or optionally liquid stream (S1) is not more than 100°C lower than the adsorber, especially during the cooling steps b4) and/or b5) and wherein the streams (S1) and/or (S0) originate from an organic composition which has been earlier purified by the same adsorber (A) or by a similar further adsorber during the operation mode of the respective adsorber.

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2. The process according to claim 1, wherein at least one of the heat exchange units (HEU1) and (HEU2) and/or any further heat exchange unit employed in the process is an evaporator based on heat recovery or a superheater based on heat recovery.

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

i) in step d) the heat exchange unit (HEU1) is an evaporator in order to convert stream (S1) from liquid into gaseous phase and/or in step c) the heat exchange unit (HEU2) is a superheater in order to superheat stream (S1) and/or

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ii) stream (S1) is passed in step a) through heat exchange unit (HEU1) prior to (HEU2).

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4. The process according to any of claims 1 to 3, wherein

i) at least one evaporator is a Kettle-evaporator or a shell-and-tube evaporator and/or

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- ii) at least one super-heater is a tube bundle heat exchanger and/or
- iii) stream (S1) is passed in step a) through at least one superheater (SH1), preferably operated with steam, prior to being passed through heat exchange unit (HEU2), and/or
- iv) stream (S1) is passed in step a) through at least one evaporator, preferably operated with steam, prior to being passed through heat exchange unit (HEU2), and/or
- v) stream (S1) is passed in step a) through at least one further super-heater, preferably an electric super-heater, after passing heat exchange unit (HEU2).
5. The process according to any of claims 1 to 4, wherein stream (S2) is passed countercurrently to stream (S1) through the heat exchange unit in step c) and/or step d).
6. The process according to any of claims 1 to 5, wherein the stream (S1)
- i) comprises at least 99 wt-% of at least one alkane, preferably at least 99.5 wt-% of at least one alkane, most preferably at least 99.9 wt-% of at least one alkane, preferably the alkane is butane, and/or
- ii) comprises not more than 1000 wt-ppm olefin, preferably not more than 500 wt-ppm olefin, most preferably not more than 100 wt-ppm olefin, preferably the olefin is butene.
7. The process according to any of claims 1 to 6, wherein
- stream (S1) is obtained in a step e), carried out prior to step a), by hydrogenation of a stream (S0), and stream (S0) comprises at least one alkane and at least one olefin in a total of at least 96 wt-%, more preferably in a total of at least 99 wt-%, most preferably in a total of at least 99.5 wt-%.
8. The process according to any of claims 1 to 7, wherein stream (S2)
- i) comprises at least one alkane and not more than 1000 wt-ppm olefin, preferably not more than 500 wt-ppm olefin, most preferably not more than 100 wt-ppm olefin, preferably the olefin is butene and/or

- ii) optionally at least one compound containing oxygen and/or sulphur and/or
 - 5 iii) is cooled/condensed with at least one condenser and/ or cooler after being treated according to c) and/or d).
- 9. The process according to any of claims 1 to 8, wherein step a) comprises at least one of the component steps a1) to a6):
- 10 a1) feeding a liquid stream (S1) into a flash vessel (FV) to obtain gaseous stream (S1) and liquid stream (S1);
- 15 a2) superheating gaseous stream (S1), optionally obtained in any of component steps a1), a3), a4), a5) and/or a6), in a super-heater (SH1), preferably a steam-based super-heater;
 - 20 a3) superheating gaseous stream (S1), optionally obtained in any of component steps a1), a2), a4), a5) and/or a6), in a heat exchange unit (HEU2), which is a super-heater, wherein heat is recovered from stream (S2);
 - 25 a4) super-heating gaseous stream (S1), optionally obtained in any of component steps a1), a2), a3), a5) and/or a6), in a further super-heater (H), preferably an electric super-heater;
 - 30 a5) converting liquid stream (S1), optionally obtained in component step a1), in a heat exchange unit (HEU1), which is an evaporator, wherein heat is recovered from stream (S2), into gaseous stream (S1) used in any of steps a2), a3) and/or a4);
 - 35 a6) converting liquid stream (S1), optionally remained from step a5), in an evaporator (E), preferably a steam-based evaporator, into gaseous stream (S1) and the gaseous stream (S1) obtained is used in any of the steps a2), a3), and/or a4);
- preferably step a) comprises all component steps a1) to a6),
 - preferably all optional relations are non-optional and/or
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preferably the steps a2), a3) and a4) are conducted in the order a2), followed by a3), followed by a4).

- 5 10. The process according to claim 1, wherein the flow direction of the gaseous stream (S1) through the adsorber (A) in steps b1), b2) and/or b3) is opposite to the flow direction of any organic composition through the same adsorber (A) during its operation mode, and/or the gaseous stream (S1) in step b4) and/or the liquid stream (S1) in step b5) have the same flow direction through the adsorber (A) as the flow direction of any organic composition through the same adsorber (A) during its operation mode.
- 10 11. The process according to claim 7, wherein an oligomerization of olefins, preferably a dimerization of butene to octene, and/or a distillation step to separate butane from butene is carried out prior to hydrogenation step e) and after the purification of the organic composition employing at least one adsorber in its operation mode.
- 15 12. The process according to any of claims 1 to 11, wherein the adsorber (A) to be regenerated in step a) is part of an assembly which contains at least one further adsorber, preferably the at least one further adsorber is under its operation mode during the regeneration of the first adsorber (A) and/or each adsorber within this assembly is identical in respect of the adsorber material and/or its modes of operation.
- 20 13. The process according to claim 7, wherein the stream (S0) comprises butane and butene, preferably at least 96 wt-% butane and not more than 4 wt-% butene.
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