

Claims

1. A nitrogen rejection unit (5) for extracting nitrogen and carbon dioxide from a material, the unit comprising:
 - 5 a first housing (9) comprising a first chamber for holding a first volume of the material at a first pressure and a first temperature that is below or equal to the condensation temperature of the carbon dioxide at the first pressure and greater than the condensation temperature of nitrogen;
an outlet for removing the carbon dioxide as a liquid from the first
10 chamber of the first housing (9) and a pathway for gaseous nitrogen to pass into a second chamber of the first housing;
means for transporting nitrogen from the first housing to a second housing, wherein the second housing holds the nitrogen at a second temperature that is below or equal to the condensation temperature of
15 nitrogen; and
a conduit for guiding liquid nitrogen from the second housing through and/or around the first housing to cool the material within the first housing to the first temperature.
- 20 2. A nitrogen rejection unit (5) according to claim 1, wherein the nitrogen expands as it passes from the first housing (9) to the second housing (11) such that material in the second housing is at a second pressure that is lower than the first pressure.
- 25 3. A nitrogen rejection unit (5) according to claim 2, wherein energy from the expansion of the nitrogen as it passes from the first housing (9) to the second housing (11) is used to compress the first volume of material entering the first housing.
- 30 4. A nitrogen rejection unit (5) according to claim 3, wherein the nitrogen passes through an expansion turbine (23) as it passes from the first housing (9) to the second housing (11), and the expansion turbine is configured to drive a

compressor (21) for compressing the first volume of the material to the first pressure.

5. A nitrogen rejection unit (5) according to any of claims 1 to 4, wherein liquid
5 nitrogen flows from the second housing (11), through and/or around the first housing (9) along a pipe (25) that forms a tortuous path, and then back to the second housing.
6. A nitrogen rejection unit (5) according to claim 2, wherein the material within
10 the first housing (9) is held at a pressure between 100 bar and 200 bar and the material within the second housing (11) is held at a pressure between 25 bar and 75 bar.
7. A nitrogen rejection unit (5) according to any of claims 1 to 6, wherein the
15 second temperature is around -196°C.
8. A nitrogen rejection unit (5) according to any of claims 1 to 7, wherein the first
housing comprises at least two cooling chambers and the material within the
20 first housing is cooled to the first temperature in a first chamber (31) and to a third, lower, temperature in a second chamber (33).
9. A nitrogen rejection unit (5) according to claim 8, wherein the first housing
comprises four cooling chambers (31; 33; 35; 37) and the material within the
25 first housing is cooled to the first temperature in the first chamber (31), to the third temperature that is between the first temperature and the second temperature in the second chamber (33), and to a fourth temperature that is between the third temperature and the second temperature in the third chamber (35), and to a fifth temperature that is between the fourth
30 temperature and the second temperature in a fourth chamber (37).
10. A nitrogen rejection unit (5) according to claim 9, wherein the first temperature
is 10°C, the third temperature is -85°C, the fourth temperature is -125°C, and
the fifth temperature is -150°C, and wherein CO₂ is removed as liquid from the

first chamber (31) of the first housing, methane is removed as a liquid from the second chamber (33) of the first housing, oxygen is removed as a liquid from the third chamber (35) of the first housing, and the nitrogen is transported as a liquid from the fourth chamber (37) of the first housing to the second housing.

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11. A nitrogen rejection unit (5) according to any of claims 8 to 10, wherein each cooling chamber (31; 33; 34; 37) is provided with a separate cooling system comprising an outlet for liquid nitrogen from the second housing (11) and one or more conduits for liquid nitrogen to flow from the outlet in and/or around the cooling chamber.

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12. A nitrogen rejection unit (5) according to any of claims 1 to 11, wherein the temperature of the material within the first housing (9) is regulated by adjusting the flow rate of the liquid nitrogen through and/or around the first housing.

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13. A nitrogen rejection unit (5) according to claim 12 when dependent from claim 11, wherein each cooling system comprises a temperature sensor (29) for measuring a temperature of the material within the chamber (31; 33; 34; 37) and a pump for moving fluid from the outlet and through the one or more conduits, wherein the action of the pump is controlled in response to a temperature measured by the temperature sensor (29) to maintain the temperature of the material in the chamber (31; 33; 34; 37) within a pre-determined range of temperatures.

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14. A method for extracting nitrogen from a gas comprising nitrogen and carbon dioxide, the method comprising:

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compressing, using a compressor (21), a volume of the gas to a first pressure, transferring the volume of gas to a first chamber (31) of a first housing (9), and cooling it to a first temperature that is below or equal to the condensation temperature of carbon dioxide and greater than the condensation temperature of nitrogen;

removing the carbon dioxide as a liquid from the first chamber (31) of the first housing (9);

transporting the nitrogen or allowing the nitrogen to pass as a gas from the first chamber to a second chamber (33) of the first housing (9);

5 transporting the nitrogen or allowing the nitrogen to pass from the first housing to a second housing (11) where it is at a second pressure and a second temperature which is below the condensation temperature of nitrogen at the second pressure;

removing liquid nitrogen from the second housing (11) and passing at least some of the liquid nitrogen from the second housing (11) through or around the first housing (9) to cool the material therein.

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15. The method according to claim 14, wherein the nitrogen is passed from the first housing (9) to the second housing (11) through an expansion turbine (23) such that it reaches a second pressure that is lower than the first pressure, and wherein the expansion turbine (23) is used to drive the compressor (21).

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