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DESCRIPTION

This invention relates to an air separating device by means of cryogenic distillation, in particular for producing nitrogen, in accordance with the preamble of claim 1 and known from document US-6351969-B1

A nitrogen generator described in US-A-5899093 comprises an exchange line wherein the air to be distilled is cooled, a distillation column wherein the air is separated into a nitrogen-rich flow at the head of the column and into an oxygen-enriched flow at the bottom of the column. In order to provide the reflux, a portion of the nitrogen-rich flow is delivered to a reboiler-condenser where it is condensed by exchanging heat with the oxygen-enriched flow. Alternatively the nitrogen can be condensed in a dephlegmator. The rich liquid partially vaporised in the dephlegmator is delivered to a phase separator and the liquid formed in the separator again flows to the dephlegmator. This invention aims to suppress the bath reboiler-condenser, which imposes constraints in terms of:

- investment cost, in particular to provide a recirculation of liquid
- concentration of impurities (CnHm, N₂O, CO₂, etc.)
- liquid purge
- level maintaining
- level measurement

According to an object of the invention, a device according to claim 1 is provided.

According to optional objects:

- the device comprises means of trickling and/or expanding air or rich vaporised liquid;
- the supply line for delivery of the compressed purified and cooled air from the exchange line to the distillation column is connected to the cold end of the heat exchange section;
- the device comprises means for redistributing the passages between the heat exchange section and the rectifying section;
- the exchange line is made of copper or of aluminium and/or the distillation column is made of stainless steel;
- the exchange line and the distillation column are made of aluminium;
- the exchange line is a plate exchanger with brazed fins.

The invention proposes to integrate the "vaporisation-condensation" function into the main exchanger by using the coldest portion of the exchanger as a dephlegmator so as to condense the nitrogen therein. The invention is interesting in that it features the following advantages:

- There is a "natural" purge of the rich liquid, which is not very concentrated by vaporisation (just like a device fitted with a pump).
- As there is no longer any need to purge the deconcentration liquid, this makes it possible:

- to suppress the equipment that is associated with it, including the stone pit (or purge boot) required due to a regular purge and including the equipment that makes it possible to ensure the reliability and effectiveness of the purge,
- a gain in cooling power (for a trickle device, the consumption of liquid nitrogen is highly reduced, which leads to a reduction in operating costs),
- to reduce the operational monitoring of this purge, which is critical in terms of safety.
- Suppression of the level measurement, of the heating clamps of the sensing lines, of any bubblers and of the level gauge and reduction of the operational monitoring of this measurement, which is critical in terms of safety.
- Suppression of the recirculation pot.

The extra cost on the exchanger is marginal, and even zero if a portion of the gain in the cooling power in a slightly less efficient exchange line (and therefore not as large) is converted.

The cold box is higher, but much smaller because the exchanger is above the column, which results in a substantial gain.

The invention shall be described in further detail and with reference to the figure, which shows an air separating device according to the invention.

A flow of compressed air 1 is purified in a purification unit (not shown) and delivered to the hot end of an exchange line 3. The exchange line comprises a conventional heat exchange section 3A and a rectifying section 3B. The two sections are contiguous and the exchange line is a plate exchanger with brazed fins.

The air 1 is cooled in the exchange line until the cold end of the section 3A, and then exits from the exchange line to be delivered at the bottom of a simple distillation column 7. The column 7 contains structured packings or plates 9.

The air is separated into an oxygen-enriched flow 11 and a nitrogen-enriched flow. The flow enriched in oxygen 11 is withdrawn in liquid form from the column 7 and delivered to the cold end of the section 3B. The nitrogen-enriched gas directly exits from the head of the column in the passages of the section 3B. Preferably the exchange line 3 has the same width as the head of the column 7 and is welded to the ferrule of the column (by a round-square or round-rectangular adaptor part).

The frigories required for the distillation are supplied by trickling of liquid nitrogen 13, coming from storage in a known manner described in EP-A-0452177. Alternatively or additionally a turbine of air 5 or of rich vaporised liquid can be provided.

The section 3B comprises two passages of nitrogen for one passage of rich liquid. The rich liquid is vaporised entirely in this section 3B of the exchange line 3 in such a way that it is transformed entirely into gas 15.

The nitrogen is partially condensed: the condensed portion falls by gravity in the column to serve as reflux, the exchange line 3 being installed above the column via direct welding. The remainder of the gaseous nitrogen 17 continues to ascend through the entire exchange line 3.

5 The section 3A of the exchange line is composed of the conventional main exchange line. The gaseous nitrogen 17 and the rich vaporised liquid 15 are heated facing the incoming air 1.

In order to optimise the exchange line 3, at the interface between the two sections, the double nitrogen passages of the rectifying section 3B can be reassigned between the nitrogen to be heated and the air to be cooled of the section 3A. This can be carried out by input/output of fluid (distribution box), or, preferably, by internal redistribution (use of bars and perforated separating sheets).

10 The exchange line 3 is preferably made of copper or of aluminium and the column 7 will be made of stainless steel. If the exchange line is made of aluminium and the column made of stainless steel, a mixed junction or junctions between the two must be provided. Otherwise the exchange line 3 and the column 7 can be made of aluminium.

Patentkrav

1. Apparat til separation af luft ved kryogen destillation med henblik på fremstilling af nitrogen, omfattende:

- 5 a) en vekslerledning (3), der er en pladeveksler med loddede ribber,
- b) en simpel destillationskolonne (7), som indeholder plader og/eller strukturerede beklædninger,
- c) en ledning (1) til levering af komprimeret og rensset luft til vekslerledningen,
- 10 d) en ledning for tilførsel af komprimeret, rensset og afkølet luft fra vekslerledningen til destillationskolonnen,
- e) en ledning (11) til bortsugning af en væske, der er beriget med ilt, fra kolonnen, og sende den til vekslerledningen, og hvorved vekslerledningen omfatter to sammenhængende afsnit, der er et rektificeringsafsnit (3B) og
- 15 et varmevekslerafsnit (3A); hvorved rektificeringsafsnittet er forbundet til kolonnen og til ledningen for væske, som er beriget med ilt, og hvorved varmevekslerafsnittet er forbundet til luftledningen og rektificeringsafsnittet, hvorved vekslerledningen (3) er beliggende oven over destillationskolonnen (7),
- 20 **kendetegnet ved, at** rektificeringsafsnittet (3B) er fastgjort til kolonnens (7) hoved, og kolonnen samt rektificeringsafsnittet er arrangeret således, at den med nitrogen berigede gas udtræder direkte fra kolonnens hoved i denne sektion's passager.

- 25 **2.** Apparat ifølge krav 1, omfattende midler til pibling (13) og/eller afspænding af luft (5) eller af fordampningsberiget væske.

- 3.** Apparat ifølge krav 1 eller 2, hvorved ledningen for levering af komprimeret, rensset og afkølet luft fra vekslerledningen til destillationskolonnen er forbundet til
- 30 varmevekslerafsnittets (3A) kolde ende.

4. Apparat ifølge et af de foregående krav, omfattende midler til omfordeling af passagerne mellem varmevekslerafsnittet og rektificeringsafsnittet.

- 5.** Apparat ifølge et af de foregående krav, hvorved vekslerledningen (3) er fremstillet af kobber eller af aluminium, og/eller destillationskolonnen (7) er af rustfrit stål.
- 5 **6.** Apparat ifølge et af de foregående krav, hvorved vekslerledningen (3) og destillationskolonnen (7) er af aluminium.

