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(54) **A method and installation for the removal of nitrogen from natural gas**

Verfahren und Anlage zur Entfernung von Stickstoff aus Erdgas

Procédé et installation pour l'élimination d'azote de gaz naturel

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EP 0 780 649 B1

Description

[0001] The present invention relates to a method and installation for the removal of nitrogen from natural gas by means of cryocondensation.

[0002] Nitrogen is not wanted in natural gas because nitrogen does not contribute to a higher flame temperature, on the contrary, nitrogen is ballast; therefore nitrogen needs to be removed from natural gas.

[0003] Moreover, at high flame temperatures nitrogen is known to bind to oxygen, forming toxic NO_x compounds.

[0004] These reasons also make it clear that for the combustion process nitrogen is a most undesirable gas.

[0005] It is generally known that oxyfuel is a much applied process, in which during the combustion process pure oxygen is used instead of air with the aim to improve the efficiency of ovens. It goes without saying that here also the nitrogen present in the air (about 79% by volume) is merely ballast which, apart from the disadvantages just mentioned, leads to heat loss because nitrogen is blown into the atmosphere as warmed up gas.

[0006] In US-A-5,036,671 a method is described for producing a methane-rich liquid stream from a stream of natural gas containing nitrogen. The natural gas is liquefied at a pressure above atmospheric pressure, after which it is expanded to a lower pressure, thereby concentrating the nitrogen in the vapor phase.

[0007] The object of the invention is the removal of nitrogen from natural gas and the use of pure oxygen, resulting in increased efficiency.

[0008] To this end the nitrogen present in the natural gas has to be removed before the natural gas enters the combustion process.

[0009] To this end the present invention provides a method according to claim 1 and an installation according to claim 4.

[0010] According to the prior art cryocondensation of hydrocarbons is carried out using cold nitrogen as cooling means.

[0011] According to the present invention the disadvantages mentioned above are effectively removed.

[0012] It has been shown that the method according to the invention is particularly suitable for the removal of nitrogen from natural gas having a nitrogen content of about 14% by volume.

[0013] Basically the general idea of the invention is that the liquid oxygen is boiled off in a cryocondensation unit, causing the hydrocarbons to condense. After heating, the condensed hydrocarbons, together with the gaseous oxygen that has developed, can be used in the combustion process.

[0014] The natural gas to be treated is preferably pre-cooled in a heat exchanger to about -80°C before cooling with liquid oxygen to about -165°C.

[0015] In comparison to the prior art, the method according to the invention provides the following advantages:

1) The toxic NO_x compounds are reduced to a minimum.

2) A highly calorific natural gas is obtained from a natural gas of low calorific value such as, for instance, natural gas from the North Sea.

3) A natural gas is obtained having a greater combustion efficiency, which natural gas is particularly suitable for use in melting furnaces in the glass industry, ceramic industry, steel industry and non-ferro industry.

[0016] Further, the present invention relates to an installation for the removal of nitrogen from natural gas, characterized in that the installation is provided with a storage tank for liquid oxygen, which tank is connected by means of a pipe with a first heat exchanger for the condensation of the natural gas which, via a pipe and the first heat exchanger is linked to a second heat exchanger, from which the nitrogen-free condensed natural gas via a pipe, after being heated in the second heat exchanger, arrives via a pipe in a burner, while liquid oxygen from the first heat exchanger enters via a pipe a third heat exchanger to be fed in the gaseous phase via a pipe to the burner and gaseous nitrogen is removed from the first heat exchanger via a pipe.

[0017] The invention will now be further elucidated with reference to the drawing which illustrates a preferred embodiment of the installation in accordance with the invention.

[0018] In the drawing the installation according to the invention is indicated by reference number (1). The installation (1) according to the invention is provided with a storage tank (2) for liquid oxygen.

[0019] The installation is further provided with first, second and third heat exchangers (3,4, and 11).

[0020] Natural gas, for instance from Groningen, having a nitrogen content of 14% by volume is fed via a pipe (7) to the first heat exchanger (4) in which the natural gas is cooled to - 80°C. Via valve (15) the thus cooled natural gas is led to the second heat exchanger (3) in order to be further cooled with the aid of liquid oxygen to -160°C to -165°C, which liquid oxygen is led from the storage tank (2) into the third heat exchanger via pipe (5) and tap (14). Via pipe (6) the hydrocarbons condensed in the second heat exchanger (3) are fed into the first heat exchanger (4), where the liquid hydrocarbons become gaseous and in that form are transported via a pipe (13) to a burner (12) of a melting furnace.

[0021] Further, oxygen coming from the second heat exchanger (3) in liquid form is led via a pipe (9) and a tap (16) to the the third heat exchanger (11) and then to the burner (12). In the third heat exchanger (11) cold gaseous oxygen is further heated to ambient temperature. Via a pipe (10) the gaseous oxygen is united with the hydrocarbons in the burner (12) of the melting furnace.

Claims

1. A method for the removal of nitrogen from natural gas by means of cryocondensation, **characterized** in that liquid oxygen is used as the cooling means, that the liquid oxygen is fed to a heat exchanger where the nitrogen-rich natural gas is condensed and the residual gaseous nitrogen is discharged while after being warmed up, the nitrogen-free condensed hydrocarbons as well as the boiled off gaseous oxygen, are led to a burner.
2. A method in accordance with claim 1, **characterized** in that the natural gas has a nitrogen content of about 14% by volume.
3. A method in accordance with claims 1-2, **characterized** in that the natural gas is first precooled in a heat exchanger to about -80°C before cooling with liquid oxygen to about -165°C.
4. An installation for the removal of nitrogen from natural gas, **characterized** in that the installation (1) is provided with a storage tank (2) for liquid oxygen, which tank (2) is connected by means of a pipe (5) with a first heat exchanger (3) for the condensation of the natural gas which, via a pipe (7) and the first heat exchanger (3) is linked to a second heat exchanger (4), from which the nitrogen-free condensed natural gas via a pipe (6), after being heated in the second heat exchanger (4), arrives via a pipe (13) in a burner (12), while liquid oxygen from the first heat exchanger (3) enters via a pipe (9) a third heat exchanger (11) to be fed in the gaseous phase via a pipe (10) to the burner (12) and gaseous nitrogen is removed from the first heat exchanger (3) via a pipe (8).

flüssigem Sauerstoff auf etwa -165 °C abgekühlt wird, in einem Wärmeaustauscher auf etwa -80 °C vorgekühlt wird.

4. Vorrichtung zur Entfernung von Stickstoff aus Erdgas, **dadurch gekennzeichnet**, dass die Vorrichtung (1) mit einem Lagertank (2) für flüssigen Sauerstoff versehen ist, an welchen über die Rohrleitung (5) ein erster Wärmeaustauscher (3) für die Kondensation des Erdgases angeschlossen ist, das über die Rohrleitung (7) und den ersten Wärmeaustauscher (3) mit einem zweiten Wärmeaustauscher (4) verbunden ist, aus welchem das stickstofffreie kondensierte Erdgas über die Rohrleitung (6), nachdem es in dem zweiten Wärmeaustauscher (4) erwärmt worden ist, über die Rohrleitung (13) den Brenner (12) erreicht, während der flüssige Sauerstoff von dem ersten Wärmeaustauscher (3) über die Rohrleitung (9) in einen dritten Wärmeaustauscher (11) gelangt, um als gasförmige Phase über die Rohrleitung (10) dem Brenner (12) zugeleitet zu werden, wobei der gasförmige Stickstoff über die Rohrleitung (8) aus dem ersten Wärmeaustauscher (3) entfernt wird.

Revendications

1. Méthode pour retirer le nitrogène d'un gaz naturel par cryocondensation caractérisée en ce que de l'oxygène liquide est utilisé comme agent de refroidissement; l'oxygène liquide est apporté à un échangeur de chaleur dans lequel le gaz naturel riche en nitrogène est condensé et le nitrogène gazeux résiduel est évacué après avoir été réchauffé, les hydrocarbures libres de nitrogène ainsi que l'oxygène gazeux dégagés par ébullition sont dirigés vers un brûleur.

Patentansprüche

1. Verfahren zur Entfernung von Stickstoff aus Erdgas durch Kryokondensation, **dadurch gekennzeichnet**, dass als Kühlmittel flüssiger Sauerstoff verwendet und der flüssige Sauerstoff einem Wärmeaustauscher zugeführt wird, wo das stickstoffreiche Erdgas kondensiert und der übrig bleibende gasförmige Stickstoff abgelassen wird, wobei nach Erwärmen die stickstofffreien kondensierten Kohlenwasserstoffe sowie der verdampfte gasförmige Sauerstoff einem Brenner zugeleitet werden.
2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet**, dass der Stickstoffgehalt des Erdgases etwa 14 Vol.-% beträgt.
3. Verfahren nach den Ansprüchen 1 bis 2, **dadurch gekennzeichnet**, dass das Erdgas, bevor es mit

2. Méthode selon la revendication 1 caractérisée en ce que le gaz naturel renferme environ 14% en volume de gaz naturel.
3. Méthode selon les revendications 1 et 2 caractérisée en ce que le gaz naturel est préalablement refroidi dans un échangeur de chaleur à environ moins 80°C avant le refroidissement par l'oxygène liquide à environ moins 165°C.
4. Installation (1) pour retirer le nitrogène d'un gaz naturel caractérisée en ce qu'elle comprend un réservoir (2) de stockage de l'oxygène liquide, ce réservoir (2) est relié par une conduite (5) avec un premier échangeur de chaleur (3) pour la condensation du gaz naturel, lequel est par une conduite (7) et le premier échangeur de chaleur (3) envoyé à un second échangeur de chaleur (4) d'où le gaz naturel condensé libre de nitrogène par une conduite (6),

après avoir été chauffé dans le second échangeur de chaleur, arrive par une conduite (13) à un brûleur (12) tandis que l'oxygène liquide par le premier échangeur de chaleur 3 pénètre par une conduite (9) dans un troisième échangeur de chaleur (11) pour alimenter en phase gazeuse le brûleur (12) par une conduite (10) et que le nitrogène gazeux est extrait du premier échangeur de chaleur (3) par une conduite (8).

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