



(22) Date de dépôt/Filing Date: 2016/11/15  
(41) Mise à la disp. pub./Open to Public Insp.: 2017/06/01  
(45) Date de délivrance/Issue Date: 2023/10/31  
(30) Priorité/Priority: 2015/12/01 (DE102015015524.5)

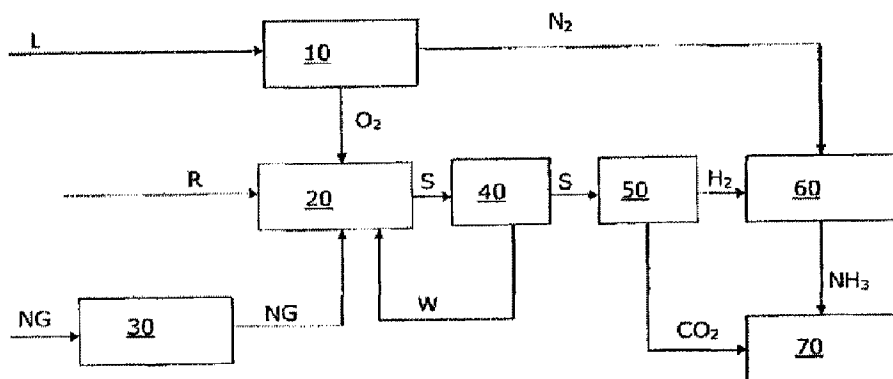
(51) Cl.Int./Int.Cl. *C07C 273/04* (2006.01),  
*C01B 3/48* (2006.01), *C01B 3/50* (2006.01)

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(54) Titre : PROCÉDE DE FABRICATION D'UREE  
(54) Title: METHOD FOR THE MANUFACTURE OF UREA



(57) **Abrégé/Abstract:**

The invention relates to a method for producing urea, comprising the steps: reacting a methane-containing and also, preferably desulphurized, feed gas stream (NG) with oxygen by partial oxidation (20) to form a synthesis gas stream (S) comprising hydrogen and carbon monoxide, reacting carbon monoxide of the synthesis gas stream (S) in a water gas-shift reaction (40) with water to form carbon dioxide and hydrogen, dividing the synthesis gas stream (S) into at least one first and one second synthesis gas substream (S', S''), wherein the first synthesis gas substream (S') is subjected to a pressure-swing adsorption (50, 51), wherein hydrogen is separated off from the first synthesis gas substream (S'), and wherein the second synthesis gas substream (S'') is subjected to a temperature-swing adsorption (50, 52), wherein carbon dioxide is separated off from the second synthesis gas substream (S''), reacting (60) hydrogen separated off from the first synthesis gas substream (S') with nitrogen to form ammonia, and reacting (70) ammonia with carbon dioxide separated off from the second synthesis gas substream (S'') to form urea.

AbstractMethod for the manufacture of urea

The invention relates to a method for producing urea, comprising the steps: reacting a methane-containing and also, preferably desulphurized, feed gas stream (NG) with oxygen by partial oxidation (20) to form a synthesis gas stream (S) comprising hydrogen and carbon monoxide, reacting carbon monoxide of the synthesis gas stream (S) in a water gas-shift reaction (40) with water to form carbon dioxide and hydrogen, dividing the synthesis gas stream (S) into at least one first and one second synthesis gas substream (S', S''), wherein the first synthesis gas substream (S') is subjected to a pressure-swing adsorption (50, 51), wherein hydrogen is separated off from the first synthesis gas substream (S'), and wherein the second synthesis gas substream (S'') is subjected to a temperature-swing adsorption (50, 52), wherein carbon dioxide is separated off from the second synthesis gas substream (S''), reacting (60) hydrogen separated off from the first synthesis gas substream (S') with nitrogen to form ammonia, and reacting (70) ammonia with carbon dioxide separated off from the second synthesis gas substream (S'') to form urea.

Fig. 1

Description

Method for the manufacture of urea

5 The invention relates to a method for the manufacture of urea.

The synthesis of urea ( $\text{H}_2\text{N-CO-NH}_2$ ) requires two important reactants, namely  $\text{CO}_2$  and ammonia ( $\text{NH}_3$ ).

10

The synthesis of ammonia for manufacturing the required ammonia, and the synthesis of urea can in this case be based on a steam reformation that provides the required hydrogen for the synthesis of ammonia or  $\text{CO}_2$  for the synthesis of urea.  $\text{CO}_2$  manufactured in this case is customarily removed by means of a scrubbing method, wherein the  $\text{CO}_2$  is generally manufactured during the regeneration of the scrubbing medium loaded with  $\text{CO}_2$ . For this purpose, the loaded scrubbing medium is typically heated at relatively low pressure, in such a manner that there is a high energy requirement for compressing the  $\text{CO}_2$  required in the synthesis of urea.

Ammonia and  $\text{CO}_2$  are the main reactants for the synthesis of urea. Ammonia is usually produced by means of air-fed ATR reformers, wherein manufactured  $\text{H}_2$  and  $\text{N}_2$  are mixed, followed by a shift reactor and a methanization reactor for converting all of the CO to methane.  $\text{CO}_2$  and methane are thereafter separated from the  $\text{H}_2\text{-N}_2$  mixture. The  $\text{H}_2\text{-N}_2$  mixture is then compressed and converted in the ammonia reactor. In an alternative layout, ammonia can be manufactured by reacting hydrogen from a steam reformer with nitrogen from an air separation unit. This layout requires, in addition to an air separation unit, a conventional hydrogen system. Hydrogen and nitrogen are mixed before being fed into the ammonia reactor and compressed. The advantage of the second

layout is the low content in inerts of the ammonia synthesis gas.

5 The ammonia that is manufactured is then converted to urea by adding CO<sub>2</sub>. The CO<sub>2</sub> manufactured in both layouts is regularly not sufficient in order to completely react the ammonia that is manufactured. Therefore, in each case CO<sub>2</sub> is imported from external sources, where present.

10

The problem addressed by the invention, against this background, is to specify an improved method for producing urea.

15 This problem is solved by, in an embodiment, a method for producing urea (H<sub>2</sub>N-CO-NH<sub>2</sub>) comprising the steps:

- reacting a methane-containing and also, preferably desulphurized, feed gas stream (in particular comprising natural gas or CH<sub>4</sub>) with oxygen by partial oxidation to form a synthesis gas stream comprising hydrogen and carbon monoxide,
- 20 - reacting carbon monoxide of the synthesis gas stream in a water gas-shift reaction with water to form carbon dioxide and hydrogen,
- 25 - dividing the synthesis gas stream into at least one first and one second synthesis gas substream,
- separating off hydrogen from the first synthesis gas substream by means of pressure-swing adsorption, and
- 30 - separating off carbon dioxide from the second synthesis gas substream by means of temperature-swing adsorption,

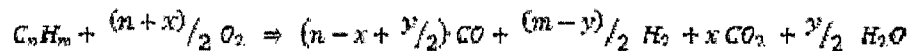
- 3 -

- reacting hydrogen (H<sub>2</sub>) separated off from the first synthesis gas substream with nitrogen (N<sub>2</sub>) to form ammonia (NH<sub>3</sub>), and
- reacting ammonia with carbon dioxide (CO<sub>2</sub>) separated off from the second synthesis gas substream to form urea.

For the manufacture of synthesis gas, accordingly, preferably partial oxidation (POX) is used. In this case, either a catalyst-based POX or a POX can be used which succeeds without a catalyst.

The feed gas stream preferably comprises one or more of the following components or hydrocarbons that are reacted in the synthesis gas manufacturing step to form the synthesis gas which comprises H<sub>2</sub> and CO; natural gas, CH<sub>4</sub>, H<sub>2</sub>O, CO<sub>2</sub>.

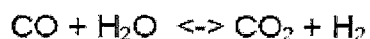
In the partial oxidation, the preferably prepurified, in particular desulphurized (see also below) feed gas stream which comprises, e.g. natural gas or CH<sub>4</sub>, or higher hydrocarbons such as naphtha, LPG, oil or else coal, is reacted, in particular, substoichiometrically in an exothermic process. Reaction products are primarily the materials hydrogen and carbon monoxide that form the synthesis gas and are obtained according to



In the partial oxidation, steam can also be added as a reactant.

In said water gas-shift reaction, to which the synthesis gas stream that is manufactured by POX is subjected, according to

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CO that is present in the synthesis gas is reacted with water to form carbon dioxide and hydrogen, which here is particularly advantageous, since firstly hydrogen is  
5 required for the synthesis of ammonia and CO<sub>2</sub> is required for the synthesis of urea.

According to an embodiment of the invention, it is further provided that the carbon dioxide that is  
10 separated off in the separation is provided at a high pressure of at least 20 bar, preferably at least 30 bar, most preferably at least 50 bar.

According to an embodiment of the invention, it is further provided that the carbon dioxide that is  
15 separated off is provided at least stoichiometrically for the reaction of ammonia to form urea, in such a manner that the ammonia (NH<sub>3</sub>) is completely reacted to form urea.

20 According to an embodiment of the invention, it is further provided that in the temperature-swing adsorption for separating off the CO<sub>2</sub>, during one cycle time, CO<sub>2</sub> is adsorbed from the second synthesis gas  
25 substream on an adsorber and is then desorbed, wherein the cycle time is preferably less than 360 min, preferably less than 240 min, most preferably less than 180 min.

30 According to an embodiment of the invention, it is further provided that for separating off the hydrogen from the first synthesis gas substream, CO<sub>2</sub> and CO (and also, in particular CH<sub>4</sub>) present in the pressure-swing  
adsorption in the first synthesis gas substream are  
35 adsorbed on an adsorber at a first pressure, wherein, preferably, the adsorber is regenerated at a second

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pressure that is lower than the first pressure, wherein adsorbed CO<sub>2</sub> and CO (and also, in particular CH<sub>4</sub>) are desorbed, and wherein the adsorber, for removing the desorbed CO<sub>2</sub> and CO (and also, in particular CH<sub>4</sub>) is  
5 purged e.g. with hydrogen, with production of an corresponding off-gas.

According to an embodiment of the invention it is  
10 further provided that the off-gas of the pressure-swing adsorption is used as fuel, wherein, preferably the off-gas is burnt for heating the feed gas stream and/or for producing and/or superheating steam. In addition, off-gases can be burnt for producing energy, or  
15 optionally compressed once more and returned to the POX.

According to an embodiment of the invention, it is further provided that an off-gas produced in the  
20 temperature-swing adsorption and comprising H<sub>2</sub> and CO (and also in particular CH<sub>4</sub>) is likewise subjected to a pressure-swing adsorption in order additionally to provide hydrogen for manufacture of the ammonia, wherein, preferably, the off-gas from the temperature-  
25 swing adsorption is subjected to said pressure-swing adsorption together with the first synthesis gas substream, and/or in that the off-gas from the temperature-swing adsorption is mixed with the off-gas (comprising CO<sub>2</sub> and CO and, in particular, CH<sub>4</sub>) arising  
30 in the pressure-swing adsorption and used as fuel.

According to an embodiment of the invention, it is further provided that impurities (e.g. in the form of H<sub>2</sub>, CH<sub>4</sub> and/or CO) present in the CO<sub>2</sub> (separated off in  
35 the temperature-swing adsorption) are removed in a purification step, preferably by means of catalytic

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oxidation, upstream of the reaction of the CO<sub>2</sub> with the ammonia to form urea.

5 According to an embodiment of the invention, it is further provided that the synthesis gas stream is cooled upstream and/or downstream of the water gas-shift reaction, wherein the synthesis gas stream is preferably cooled with water, with manufacture of process steam.

10

According to an embodiment of the invention, it is further provided that heat arising during the cooling is used for regenerating an adsorber in the temperature-swing adsorption.

15

According to an embodiment of the invention, it is further provided that the oxygen required for the POX is manufactured by cryogenic separation of air, wherein during each separation nitrogen is further manufactured which is reacted with the hydrogen to form ammonia.

20

According to an embodiment of the invention, it is further provided that the feed gas stream is conducted upstream of the partial oxidation through an adsorber unit, wherein one or more sulphur compounds that are still present in the feed gas stream are adsorbed in the adsorber unit and in this case removed from the feed gas stream.

25

30 According to an embodiment of the invention, it is further provided that the synthesis gas stream or the two synthesis gas substreams are dried downstream of the water gas-shift reaction and also upstream of the pressure-swing adsorption and also temperature-swing adsorption.

35

According to a further aspect of the invention, a plant for producing urea is also proposed.

- 5 Accordingly, in an embodiment, the plant for producing urea comprises:
- 10 - a POX reactor which is configured for reacting a methane-containing and also, preferably desulphurized, feed gas stream with oxygen by partial oxidation to form a synthesis gas stream comprising hydrogen and carbon monoxide,
  - 15 - a water gas-shift reactor downstream of the POX reactor, which is configured for reacting carbon monoxide of the synthesis gas stream in a water gas-shift reaction with water to form carbon dioxide and hydrogen, wherein the plant is further configured to divide the synthesis gas stream arriving from the water gas-shift reactor into at least one first and one second synthesis gas substream,
  - 20 - a pressure-swing adsorption unit which is configured to subject the first synthesis gas substream to a pressure-swing adsorption, wherein hydrogen is separated off from the first synthesis gas substream, and
  - 25 - a temperature-swing adsorption unit, which is configured to subject the second synthesis gas substream to a temperature-swing adsorption, wherein carbon dioxide is separated off from the second synthesis gas substream,
  - 30 - an ammonia reactor which is configured for reacting hydrogen separated off from the first synthesis gas substream with nitrogen to form ammonia, and
  - 35 - a urea reactor which is configured for reacting ammonia with carbon dioxide separated off from the second synthesis gas substream to form urea.

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The plant according to the invention is, furthermore, in further embodiments, characterized by the corresponding embodiments of the method according to the invention. In this respect, the plant is preferably  
5 configured in each case to carry out the corresponding method steps of the respective embodiment of the method according to the invention.

Further features and advantages of the invention will  
10 be explained hereinafter in the description of the figures of exemplary embodiments of the invention with reference to the figures. In the figures:

Fig. 1 shows a schematic depiction of a method  
15 according to the invention for producing urea; and

Fig. 2 shows a schematic depiction of separating off  
20  $\text{CO}_2$  and  $\text{H}_2$  from a synthesis gas manufactured in the method according to the invention.

Figure 1 shows a schematic depiction of a plant and/or of a method for producing urea.

25 In this case, a feed gas stream NG comprising, e.g.,  $\text{CH}_4$  (e.g. in the form of natural gas), before a reaction to form synthesis gas (comprising  $\text{H}_2$  and  $\text{CO}$ ) S by partial oxidation 20 is subjected to a desulphurization 30 and then, by means of partial oxidation 20, in the presence  
30 of oxygen, and also, in particular steam W, is reacted to form a synthesis gas stream S that comprises  $\text{H}_2$  and  $\text{CO}$ , and also further, in particular  $\text{CH}_4$ ,  $\text{H}_2\text{O}$  and  $\text{CO}_2$ .

The synthesis gas stream S is hereafter subjected to a  
35 water gas-shift reaction 40 (see above) and cooled with water, wherein said steam W can be manufactured. In principle, heat arising during the cooling of the

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synthesis gas S can also be used for regenerating the adsorbers in the temperature-swing adsorption 51 described further below (cf. Figure 2).

5 The synthesis gas stream S is in addition dried, wherein, hydrogen and carbon dioxide of the synthesis gas stream S are separated (50), wherein the hydrogen is reacted (60) with nitrogen to form ammonia, and  
10 wherein the carbon dioxide is finally reacted with the ammonia that is manufactured to form urea.

The oxygen for the POX 20 is manufactured by cryogenic separation 10 of air L, wherein, also the nitrogen is obtained that is required for the ammonia synthesis 60.

15 According to Figure 2, the hydrogen and carbon dioxide are separated off 50, preferably in such a manner that the shifted synthesis gas stream S is subdivided into a first and second synthesis gas substream S', S'',  
20 wherein the first synthesis gas substream S' is subjected to a pressure-swing adsorption 51, wherein hydrogen is separated off from the first synthesis gas substream S', and wherein the second synthesis gas substream S'' is subjected to a temperature-swing  
25 adsorption 52 (see above) that is heated and/or cooled, preferably at least in part indirectly, e.g. via a heat-carrier medium that is not in direct contact with the adsorbent, wherein carbon dioxide is separated off from the second synthesis gas substream S''. The cycle  
30 times of such a temperature-swing adsorption are usually short and are in the range from 2 to 6 hours. The hydrogen that is separated off is then reacted together with the nitrogen to form ammonia 60 that in turn is reacted with the CO<sub>2</sub> that is separated off to  
35 form urea 70. Preferably, the CO<sub>2</sub> V arriving from the temperature-swing adsorption 52 is still further purified 53 upstream of the urea synthesis 70, in

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particular in order to remove impurities present therein such as, e.g., H<sub>2</sub>, CH<sub>4</sub> and CO, methanol.

5 In the pressure-swing adsorption 51 for separating off  
the hydrogen from the first synthesis gas substream S',  
CO<sub>2</sub> and CO and also possibly further components (such  
as, e.g. CH<sub>4</sub>) that are present in the first synthesis  
gas substream are adsorbed on an adsorber at a first  
10 pressure, wherein, preferably the adsorber is  
regenerated at a second pressure which is lower than  
the first pressure, wherein the adsorber components are  
desorbed, and wherein the adsorber, for removing the  
desorbed components, is purged, with manufacture of an  
15 off-gas A. Preferably, a plurality, in particular two  
or four, adsorbers are used in the pressure-swing  
adsorption 51, in order that as far as possible one  
adsorber can always be operated in the adsorption mode  
in such a manner that hydrogen can be released semi-  
continuously.

20 The off-gas A from the pressure-swing adsorption 51 can  
be used, e.g. as fuel, wherein, e.g. the off-gas A can  
be burnt for heating the feed gas stream NG and/or for  
producing and/or superheating steam.

25 In the temperature-swing adsorption 52, CO<sub>2</sub> is adsorbed  
at a low first temperature on an adsorber and desorbed  
at a higher second temperature, for which the necessary  
energy E is provided. The residual gas arising in the  
30 adsorption of CO<sub>2</sub> and/or off-gas A' that comprises H<sub>2</sub>  
and CO, can, together with the first synthesis gas  
substream S', be run into the pressure-swing adsorption  
51 or can be mixed with the off-gas A from the  
pressure-swing adsorption 51 and, therewith, be used  
35 together as fuel.

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On account of the separation according to the invention of CO<sub>2</sub>, said CO<sub>2</sub>, after the separation, is advantageously present at a high pressure of preferably at least 20 bar, and so correspondingly energy can be saved for the otherwise necessary compression of the CO<sub>2</sub> for the purpose of urea synthesis. This is principally due to the fact that regeneration is performed during the temperature-swing adsorption by means of heating the adsorbent, and so in comparison the pressure drop occurring during regeneration in the pressure-swing adsorption is avoidable.

In addition, in the presence of the CO<sub>2</sub> purification by catalytic oxidation, CO<sub>2</sub> arriving from the temperature-swing adsorption advantageously need not be cooled, since it must have a correspondingly elevated temperature for the catalytic oxidation.

The use of an appropriately designed catalytic oxidation can balance out the fluctuations in composition formed during the desorption and thus ensure a CO<sub>2</sub> quality as uniform as possible. The control can be adapted, in such a manner, for example, that the oxygen requirement of the catalytic oxidation is taken into account and thus an oxygen concentration in the CO<sub>2</sub> as constant as possible is always maintained, for example below 0.7% by volume, in particular below 0.6% by volume, or in particular < 0.35% by volume. This control possibility is advantageous for the stability and energy efficiency of the subsequent urea plant. For control of the O<sub>2</sub> content in the CO<sub>2</sub>, the desorption of the combustible components can be calculated in advance on account of the heating. Then, the amount of air can be set accordingly. There is also the possibility, e.g., of additionally measuring and controlling the O<sub>2</sub> content in the CO<sub>2</sub>.

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As a result, the invention permits the integration of known technologies such as, e.g., POX, ASU (cryogenic air separation), pressure-swing adsorption and temperature-swing adsorption, into one plant concept or  
5 method concept which can provide sufficient CO<sub>2</sub> for urea synthesis, and so complete reaction of the ammonia that is manufactured is possible, wherein the required CO<sub>2</sub> is provided at a high pressure level, and so a high-cost additional compression can be avoided.

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**List of reference signs**

10	Air separation
20	POX
30	Desulphurization
40	Water gas-shift reaction and cooling of the synthesis gas
50	Separating off H <sub>2</sub> and CO <sub>2</sub>
51	Pressure-swing adsorption
52	Temperature-swing adsorption
53	CO <sub>2</sub> purification
60	Ammonia synthesis
70	Urea synthesis
A, A'	Off-gas
E	Energy for heating
L	Air
NG	Feed gas
S	Synthesis gas
S'	First synthesis gas substream
S''	Second synthesis gas substream
R	Shifted synthesis gas recycle
V	CO <sub>2</sub> with impurities downstream of temperature-swing adsorption
W	Steam

Claims

1. A method for producing urea, the method comprising the steps:
  - 5 - reacting a methane-containing feed gas stream with oxygen by partial oxidation to form a synthesis gas stream comprising hydrogen and carbon monoxide,
  - reacting carbon monoxide of the synthesis gas stream in a water gas-shift reaction with water to form carbon dioxide and hydrogen,
  - 10 - dividing the synthesis gas stream into at least one first and one second synthesis gas substream,
  - 15 - wherein the first synthesis gas substream is subjected to a pressure-swing adsorption, wherein hydrogen is separated off from the first synthesis gas substream, and
  - wherein the second synthesis gas substream is subjected to a temperature-swing adsorption, wherein carbon dioxide is separated off from the second synthesis gas substream
  - 20 - reacting hydrogen separated off from the first synthesis gas substream with nitrogen to form ammonia, and
  - 25 - reacting ammonia with carbon dioxide separated off from the second synthesis gas substream to form urea.
- 30 2. The method according to Claim 1, wherein the methane-containing feed gas stream is also desulphurized.
- 35 3. The method according to Claim 1 or 2, wherein the carbon dioxide that is separated off in the separation is provided at a high pressure of at least 10 bar.

4. The method according to Claim 1 or 2, wherein the carbon dioxide that is separated off in the separation is provided at a high pressure of at least 20 bar.
- 5
5. The method according to Claim 1 or 2, wherein the carbon dioxide that is separated off in the separation is provided at a high pressure of at least 50 bar.
- 10
6. The method according to any one of Claims 1 to 5, wherein the carbon dioxide that is separated off is provided at least stoichiometrically for the reaction of ammonia to form urea, in such a manner that the ammonia is completely reacted to form urea.
- 15
7. The method according to any one of Claims 1 to 6, wherein, during the temperature-swing adsorption, carbon dioxide from the second synthesis gas substream is adsorbed and then desorbed, wherein an adsorbent used in the temperature-swing adsorption is heated and/or cooled.
- 20
8. The method according to Claim 7, wherein the adsorbent used in the temperature-swing adsorption is heated and/or cooled at least in part indirectly.
- 25
9. The method according to Claim 8, wherein the adsorbent used in the temperature-swing adsorption is heated and/or cooled at least in part indirectly via a heat-carrier medium that is not in direct contact with the adsorbent.
- 30
10. The method according to any one of Claims 1 to 9, wherein, in the temperature-swing adsorption for separating off the carbon dioxide, during one
- 35

cycle time, carbon dioxide is adsorbed from the second synthesis gas substream in an adsorber station and is then desorbed.

- 5 11. The method according to Claim 10, wherein the cycle time is less than 360 min.
12. The method according to Claim 10, wherein the cycle time is less than 240 min.
- 10 13. The method according to Claim 10, wherein the cycle time is less than 180 min.
14. The method according to any one of Claims 1 to 13, wherein, for separating off the hydrogen from the first synthesis gas substream, CO<sub>2</sub> and CO present in the pressure-swing adsorption in the first synthesis gas substream are adsorbed on an adsorber at a first pressure, wherein adsorbed CO<sub>2</sub> and CO are desorbed, and wherein the adsorber, for removing the desorbed CO<sub>2</sub> and CO, is purged with production of an off-gas (A).
- 15 20 25 15. The method according to Claim 14, wherein the adsorber is regenerated at a second pressure that is lower than the first pressure.
16. The method according to Claim 14 or 15, wherein the off-gas (A) of the pressure-swing adsorption is used as fuel.
- 30 17. The method according to Claim 16, wherein, the off-gas (A) is burnt for heating the feed gas stream and/or for producing and/or superheating steam.
- 35 18. The method according to any one of Claims 1 to 17, wherein an off-gas (A') produced in the

temperature-swing adsorption and comprising H<sub>2</sub> and CO is likewise subjected to a pressure-swing adsorption in order additionally to provide hydrogen for manufacture of the ammonia.

- 5
19. The method according to Claim 18, wherein the off-gas (A') from the temperature-swing adsorption is subjected to said pressure-swing adsorption together with the first synthesis gas substream, and/or wherein the off-gas (A') from the temperature-swing adsorption is mixed with the off-gas (A) arising in the pressure-swing adsorption and used as fuel.
- 10
20. The method according to any one of Claims 1 to 19, wherein the CO<sub>2</sub> that is separated off in the temperature-swing adsorption comprises impurities in the form of at least one of the following materials: H<sub>2</sub>, CH<sub>4</sub>, CO; wherein the impurities are removed in a purification step upstream of the reaction of the CO<sub>2</sub> with the ammonia to form urea.
- 15
21. The method according to Claim 20, wherein the impurities are removed in the purification step by means of catalytic oxidation.
- 20
22. The method according to any one of Claims 1 to 21, wherein the synthesis gas stream is cooled upstream and/or downstream of the water gas-shift reaction, with manufacture of process steam.
- 25
23. The method according to Claim 22, wherein the synthesis gas stream is cooled with water.
- 30
24. The method according to Claim 22 or 23, wherein heat arising during the cooling is used for regenerating an adsorber in the temperature-swing adsorption.
- 35

25. The method according to any one of Claims 1 to 24,  
wherein the oxygen is manufactured by cryogenic  
separation of air, wherein during the separation  
5 nitrogen is further manufactured which is reacted  
with the hydrogen to form ammonia.
26. The method according to any one of Claims 1 to 25,  
wherein the feed gas stream is conducted upstream  
10 of the partial oxidation through an adsorber unit,  
wherein one or more sulphur compounds that are  
still present in the feed gas stream are adsorbed  
in the adsorber unit (30) and in this case removed  
from the feed gas stream.
- 15 27. The method according to any one of Claims 1 to 26,  
wherein the synthesis gas stream or the two  
synthesis gas substreams are dried downstream of  
the water gas-shift reaction and also upstream of  
20 the pressure-swing adsorption and also  
temperature-swing adsorption.
28. A plant for producing urea, the plant comprising  
- a POX reactor for reacting a methane-containing  
25 feed gas stream with oxygen by partial  
oxidation to form a synthesis gas stream  
comprising hydrogen and carbon monoxide,  
- a water gas-shift reactor downstream of the POX  
reactor for reacting carbon monoxide of the  
30 synthesis gas stream in a water gas-shift  
reaction with water to form carbon dioxide and  
hydrogen, wherein the plant is configured to  
divide the synthesis gas stream arriving from  
the water gas-shift reactor into at least one  
35 first and one second synthesis gas substream,  
- a pressure-swing adsorption unit which is  
configured to subject the first synthesis gas  
substream to a pressure-swing adsorption,

wherein hydrogen is separated off from the first synthesis gas substream, and

- 5 - a temperature-swing adsorption unit, which is configured to subject the second synthesis gas substream to a temperature-swing adsorption, wherein carbon dioxide is separated off from the second synthesis gas substream,
  - 10 - an ammonia reactor for reacting hydrogen separated off from the first synthesis gas substream with nitrogen to form ammonia, and
  - a urea reactor for reacting ammonia with carbon dioxide separated off from the second synthesis gas substream to form urea.
- 15 29. The plant according to Claim 28, wherein the methane-containing feed gas stream is also desulphurized.

Fig. 1

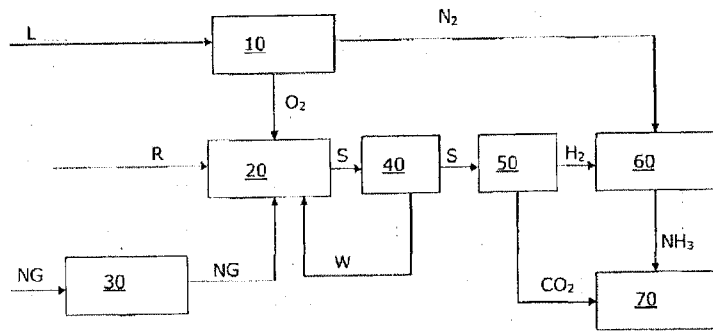


Fig. 2

