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(54) **METHOD AND DEVICE FOR GENERATING A GAS PRODUCT**

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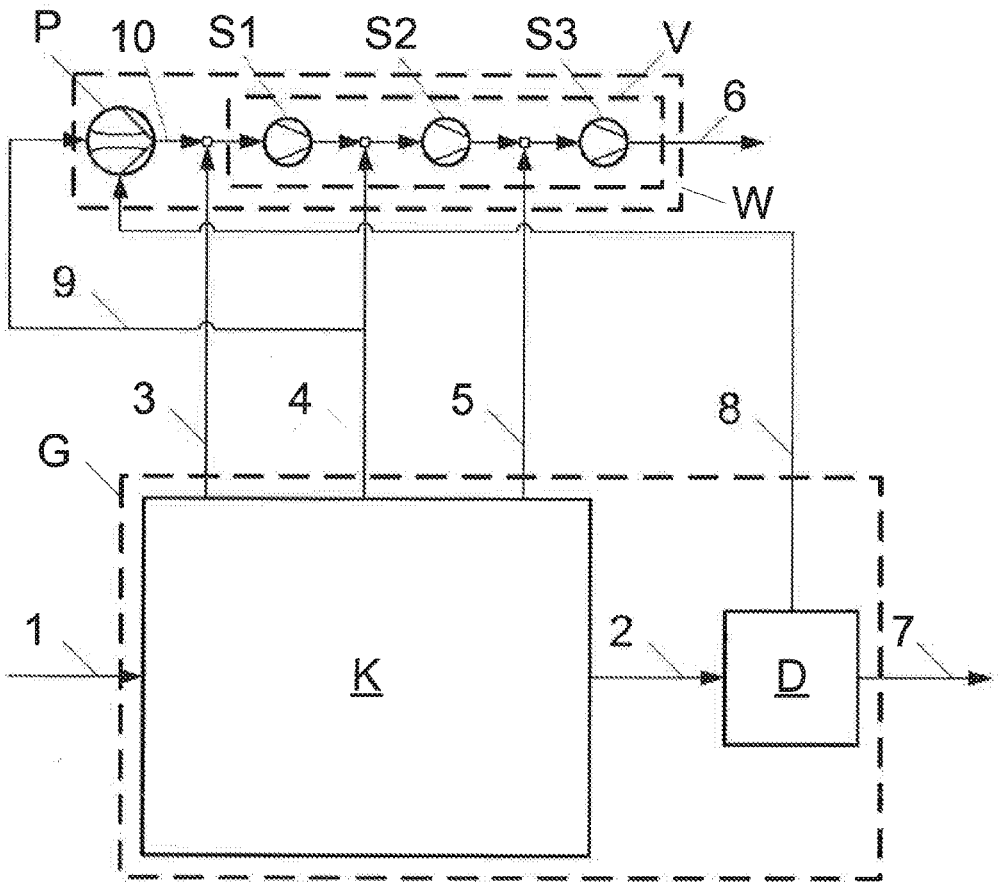
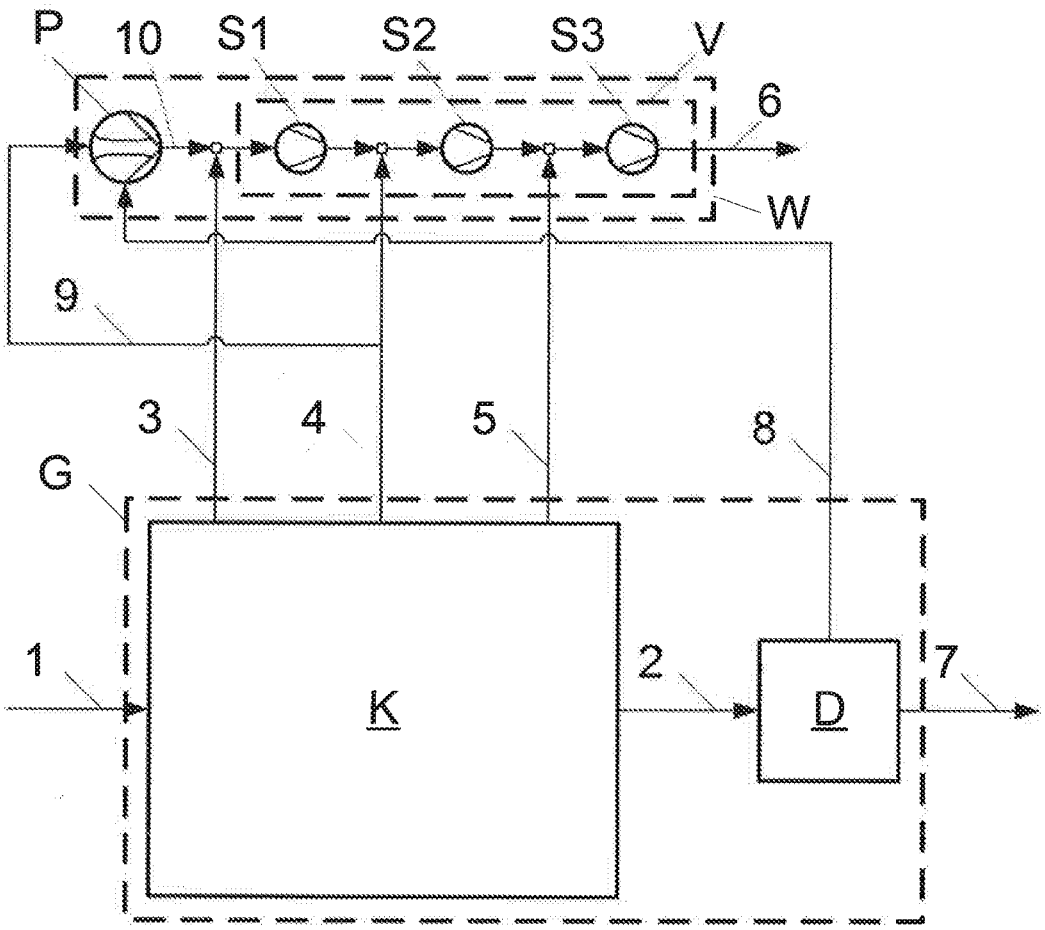
(57) **ABSTRACT**

The invention relates to a method and also a device for producing a gas product, wherein a first gas stream is combined with a second gas stream and the first gas stream that is present at a lower output pressure than the second gas stream is fed to a mechanical compressor in order to be compressed to the preset pressure of the gas product. It is characteristic in this case that the pressure of the first gas stream is elevated using a gas jet compressor arranged upstream of the mechanical compressor, to which gas jet compressor at least a part of the second gas stream is fed as pumping medium.



FIGURE



METHOD AND DEVICE FOR GENERATING A GAS PRODUCT

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from German Patent Application DE 10 2015 009562.5 filed on Jul. 23, 2015.

BACKGROUND OF THE INVENTION

[0002] The invention relates to a method for producing a gas product, wherein a first gas stream is combined with a second gas stream, and the first gas stream that is present at a lower output pressure than the second gas stream is fed to a mechanical compressor in order to be compressed to the preset pressure of the gas product.

[0003] In addition, the invention relates to a device for carrying out the method according to the invention.

[0004] Methods and devices of the type described at the outset are used, for instance in the production of a carbon monoxide product from a synthesis gas predominantly consisting of hydrogen and carbon monoxide, wherein the synthesis gas is fractionated in a cryogenic method, which is, for example, a condensation process, into carbon monoxide-containing crude hydrogen and at least one carbon monoxide stream which, although it has the purity required for the carbon monoxide product, the pressure thereof is lower than the demanded product pressure. The pressure of said carbon monoxide stream is therefore elevated to the required value using a mechanical compressor, which in some cases is constructed with a plurality of sections.

[0005] Alternatively, the mechanical compressor also serves for driving a refrigeration circuit which covers in whole or in part the refrigeration requirement of the cryogenic method. For this purpose, a part of the compressed carbon monoxide is recirculated, cooled against process streams that are to be warmed, and cold-producingly expanded or—after a proceeding condensation—vaporized. The expanded and re-warmed carbon monoxide is then again passed to the mechanical compressor.

[0006] The carbon monoxide-containing crude hydrogen is separated by adsorption into a hydrogen product and a carbon monoxide-rich purge gas which, on account of the purity thereof can be used for forming the carbon monoxide product, but the pressure of which is in the vicinity of atmospheric pressure, and therefore is substantially lower than the pressures of the other carbon monoxide streams of the method.

[0007] As mechanical compressors, according to the prior art, machines such as screw compressors, piston compressors or turbo compressors are used that have a complex structure and, because the large number of moving parts thereof, are additionally susceptible to wear and breakdown. For these machines, therefore high capital and operating costs result which have a considerable effect on the economic efficiency of carbon monoxide production which increases with decreasing pressure level of the carbon monoxide that is to be compressed.

[0008] This is of importance, in particular, when, to increase the yield of the method, the purge gas arising in the treatment of the carbon monoxide-containing crude hydrogen is likewise to be converted into the carbon monoxide product. In this case, it can be necessary to equip the mechanical compressor with an additional low-pressure section, the operation of which is accompanied by the increased risk of vacuum formation and thereby the introduction of oxygen from the surroundings, which contaminates the carbon monoxide product.

[0009] The object of the present invention is therefore to specify a method and also a device of the type in question by which it is possible to overcome the described disadvantages of the prior art.

SUMMARY OF THE INVENTION

[0010] On the method side, the object in question is achieved according to the invention in that the pressure of the first gas stream is elevated upstream of the mechanical compressor using a gas jet compressor to which at least a part of the second gas stream is fed as pumping medium.

[0011] The method according to the invention permits a mechanical compressor to be used to compress the first gas stream, the minimum suction pressure of which compressor is markedly above the output pressure of the first gas stream. Depending on pressure and amount of the part of the second gas stream used as pumping medium it is possible to dispense with one or even a plurality of low-pressure sections of the mechanical compressor, as a result of which the capital costs arising for the gas jet compressor are more than compensated for.

[0012] Gas jet compressors have been prior art for many years and are known to those skilled in the art. They have a relatively simple structure without moving parts and are robust in such a manner that they can be used at markedly lower costs than mechanical compressors or compressor sections.

[0013] In the motive nozzle of the gas jet compressor, a part of the pressure energy of the part of the second gas stream used as pumping medium is converted into kinetic energy in such a manner that a gas stream is formed, the static pressure of which is less than the output pressure of the first gas stream. By the pumping medium exiting from the motive nozzle, therefore the first gas stream can be taken in and accelerated. In the inlet cone of the diffuser following the motive nozzle, the two gas streams mix, before they are braked again in the diffuser. Since pressure energy is recovered by the braking, the first gas stream leaves the gas jet compressor together with the part of the second gas stream used as pumping medium and at a pressure higher than its output pressure.

[0014] Preferably, the part of the second gas stream that is used as pumping medium is fed to the gas jet compressor at a pressure which substantially corresponds to the output pressure of the second gas stream. Alternatively, the pressure at least of the part of the second gas stream used as pumping medium is elevated using the mechanical compressor to a value above the output pressure thereof, before it is used in the gas jet compressor.

[0015] The pressure of the first gas stream is expediently elevated using the gas jet compressor from its output value to a value which is equal to or greater than the suction pressure of the mechanical compressor in such a manner that the first gas stream can be fed to the mechanical compressor without further compression.

[0016] The method according to the invention can be used in a multiplicity of compressing tasks. Preferably, however, it is used to compress carbon monoxide streams arising at differing pressure levels in the fractionation of a synthesis gas predominantly consisting of hydrogen and carbon mon-

oxide to form a carbon monoxide product. Particularly advantageously, it can be used if a carbon monoxide stream having product purity and also a carbon monoxide-containing crude hydrogen stream are obtained from the synthesis gas in a cryogenic separation process, which crude hydrogen stream is subsequently separated by adsorption, wherein a carbon monoxide-containing purge gas is produced which, on account of the purity thereof, can be used to form the carbon monoxide product, the pressure of which, however, is lower than the pressure of the second carbon monoxide stream obtained directly in the cryogenic separation process. At least a part of this second carbon monoxide stream is then fed to a gas jet compressor as pumping medium, with which the pressure of the purge gas is elevated, in order subsequently to compress it to the pressure of the carbon monoxide product using a mechanical compressor.

[0017] Furthermore, the invention relates to a device for producing a gas product having an appliance comprising a mechanical compressor for combining a first and a second gas stream, wherein the first gas stream that is present at a lower output pressure than the second gas stream can be compressed in the mechanical compressor to the preset pressure of the gas product.

[0018] The object in question is achieved according to the invention in terms of the device in that said device has a gas jet compressor arranged upstream of the mechanical compressor for elevating the pressure of the first gas stream, to which at least a part of the second gas stream is feedable as pumping medium.

[0019] Preferably, the device according to the invention has exactly one gas jet compressor. However, this is not to exclude the case that it comprises two or more parallel- and/or serial-arranged gas jet compressors for elevating the pressure of the first gas stream, to which in each case at least a part of the second and/or a third gas stream can be fed as pumping medium.

[0020] A configuration of the device according to the invention has a gas fractionator in which a gas mixture can be fractionated in order to obtain the first gas stream and the second gas stream. Preferably, the gas fractionator comprises a cryogenic part and also a pressure-swing adsorber, wherein a synthesis gas substantially consisting of hydrogen and carbon monoxide is fractionatable in the cryogenic part into at least one carbon monoxide stream having product purity, which forms the second gas stream, and a carbon monoxide-containing crude hydrogen, from which pure hydrogen and a carbon monoxide-rich purge gas, which is the first gas stream, can be generated in the pressure-swing adsorber.

[0021] If the gas fractionator comprises a cryogenic part, the mechanical compressor can be used to drive a cooling circuit which provides refrigeration for the cryogenic part and in which a mixture of matter meeting the purity requirements made of the gas product circulates as coolant.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] Hereinafter, the invention is to be described in more detail with reference to an exemplary embodiment shown schematically in the FIGURE.

DETAILED DESCRIPTION OF THE INVENTION

[0023] The FIGURE shows an appliance for the cryogenic fractionation of a synthesis gas principally consisting of hydrogen and carbon monoxide, wherein carbon monoxide streams arising at differing pressure levels are combined to form a carbon monoxide product.

[0024] Via line **1**, a synthesis gas substantially consisting of hydrogen and carbon monoxide is introduced into the cryogenic part K of the gas fractionator G, where it is fractionated into crude hydrogen **2**, and also the carbon monoxide streams **3**, **4** and **5**. The carbon monoxide streams **3**, **4** and **5** all have a purity which would permit them to be delivered as carbon monoxide product, but they are at pressures which are lower than the required product pressure. They are therefore passed in the appliance W to the compressor V having the compressor sections S**1**, S**2** and S**3**, in order to be combined and compressed to form the carbon monoxide product **6**. The design of the compressor V is decisively determined by the carbon monoxide stream **3**, the pressure level of which is lowest.

[0025] To separate off carbon monoxide and generate a hydrogen product **7** that has a purity of greater than 99.9% by volume, the crude hydrogen **2** is fed to the pressure-swing adsorption appliance D which is part of the gas fractionator G, in the regeneration of which pressure-swing adsorption appliance a carbon monoxide-rich purge gas **8** arises at a pressure which is only slightly greater than the ambient pressure and is markedly lower than the pressure of the carbon monoxide stream **3**. In order to increase the carbon monoxide yield, the purge gas **8** is compressed in the gas jet compressor P to a pressure which is equal to or greater than the pressure of the carbon monoxide stream **3**, wherein a part **9** of the carbon monoxide stream **4** serves as pumping medium in the gas jet compressor P. The carbon monoxide stream **10** obtained in the gas jet compressor P is then combined with the carbon monoxide stream **3** and fed via the low-pressure section S**1** to the compressor V.

What we claim is:

1. A method for producing a gas product, wherein a first gas stream is combined with a second gas stream and the first gas stream that is present at a lower output pressure than the second gas stream is fed to a mechanical compressor in order to be compressed to the preset pressure of the gas product, characterized in that the pressure of the first gas stream is elevated using a gas jet compressor arranged upstream of the mechanical compressor, to which gas jet compressor at least a part of the second gas stream is fed as pumping medium.

2. The method according to claim **1**, characterized in that the part of the second gas stream that is used as pumping medium is fed directly to the gas jet compressor with substantially the output pressure of the second gas stream or subsequently to a pressure elevation carried out using the mechanical compressor.

3. The method according to claim **1**, characterized in that the pressure of the first gas stream is elevated using the gas jet compressor on the output pressure thereof to a value which is greater than or equal to the suction pressure of the mechanical compressor.

4. The method according to claim **1**, characterized in that the method is used in the production of a carbon monoxide product in which a synthesis gas predominantly consisting of hydrogen and carbon monoxide is fractionated in a cryogenic separation process, wherein a carbon monoxide-containing crude hydrogen stream and also at least one carbon monoxide stream which forms the second gas stream are obtained, and wherein the crude hydrogen stream are

separated by pressure-swing adsorption into pure hydrogen and also a carbon monoxide-rich purge gas that is the first gas stream.

5. A device for producing a gas product having an appliance comprising a mechanical compressor for combining a first gas stream and a second gas stream, wherein the first gas stream that is present at a lower output pressure than the second gas stream can be compressed in the mechanical compressor to the preset pressure of the gas product, characterized in that said device has a gas jet compressor arranged upstream of the mechanical compressor for elevating the pressure of the first gas stream, to which at least a part of the second gas stream is feedable as pumping medium.

6. The device according to claim **5**, comprising two or more parallel- and/or series-arranged gas jet compressors for elevating the pressure of the first gas stream.

7. The device according to claim **5**, comprising a gas fractionator having a cryogenic part in which at least one of the two gas streams having different pressures can be generated.

8. The device according to claim **7**, comprising a gas fractionator having a cryogenic part and also a pressure-swing adsorber, wherein a synthesis gas substantially consisting of hydrogen and carbon monoxide is fractionatable in the cryogenic part into at least one carbon monoxide stream having product purity, which forms the second gas stream, and a carbon monoxide-containing crude hydrogen stream, from which pure hydrogen and a carbon monoxide-rich purge gas, which is the first gas stream, can be generated in the pressure-swing adsorber.

9. The device according to claim **7**, characterized in that the cryogenic part of the gas fractionator can be cooled via a cooling circuit that is driven via the mechanical compressor.

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