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CA 2812632 A1 2012/04/26

(21) 2 812 632

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(86) Date de dépôt PCT/PCT Filing Date: 2011/09/27
(87) Date publication PCT/PCT Publication Date: 2012/04/26
(85) Entrée phase nationale/National Entry: 2013/03/26
(86) N° demande PCT/PCT Application No.: EP 2011/066759
(87) N° publication PCT/PCT Publication No.: 2012/052262
(30) Priorité/Priority: 2010/09/28 (DE10 2010 041 536.7)

(51) Cl.Int./Int.Cl. *B01D 53/14* (2006.01), *B01D 53/34* (2006.01), *C10L 3/10* (2006.01)

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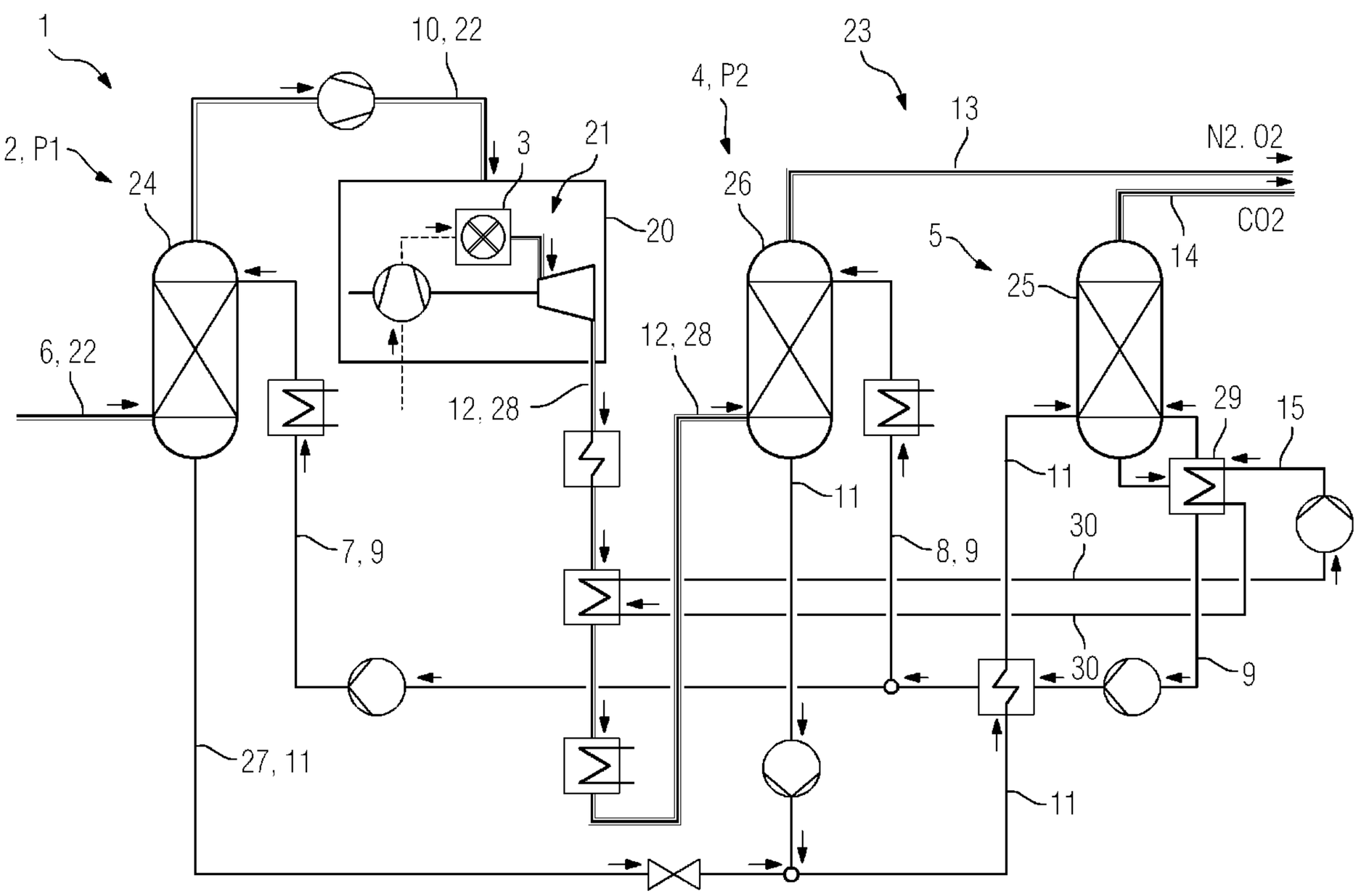
(54) Titre : PROCEDE DE SEPARATION DE DIOXYDE DE CARBONE AINSI QU'INSTALLATION DE TURBINE A GAZ A SEPARATION DE DIOXYDE DE CARBONE

(54) Title: METHOD FOR CAPTURING CARBON DIOXIDE AND GAS TURBINE PLANT WITH CARBON DIOXIDE CAPTURE



(57) Abrégé/Abstract:
Firstly, in a first absorption process (2), carbon dioxide is absorbed by contacting a supplied carbon dioxide-containing natural gas (6) with a first substream (7) of a solvent (9). In this process a carbon dioxide-depleted natural gas (10) and carbon

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(57) Abrégé(suite)/Abstract(continued):
dioxide-enriched solvent (11) are formed. Then, in a combustion process (3), the carbon dioxide-depleted natural gas (10) is burnt, with a carbon dioxide-containing exhaust gas (12) being formed. Then, in a second absorption process (4), carbon dioxide is absorbed by contacting the carbon dioxide-containing exhaust gas (12) with a second substream (8) of the solvent (9). In this process an exhaust gas (13) freed from carbon dioxide and carbon dioxide-enriched solvent (11) are formed. Then, in a desorption process (5), the first substream (7) and the second substream (8) of the carbon dioxide-enriched solvent (11) are combined and carbon dioxide (14) is desorbed by supplying heating energy (15), with carbon dioxide-depleted solvent (9) being formed.

2010P19935GC

Abstract

Method for capturing carbon dioxide and gas turbine plant with carbon dioxide capture

The invention relates to a method (1) and a device for capturing carbon dioxide. In this method, in a first absorption process (2) carbon dioxide is absorbed by bringing a supplied carbon dioxide-containing natural gas (6) into contact with a first sub-stream (7) of a solvent (9). A carbon dioxide-depleted natural gas (10) and carbon dioxide-enriched solvent (11) are formed in the process. Then the carbon dioxide-depleted natural gas (10) is combusted in a combustion process (3), a carbon dioxide-containing flue gas (12) being formed. Next, in a second absorption process (4) carbon dioxide is absorbed by bringing the carbon dioxide-containing flue gas (12) into contact with a second sub-stream (8) of the solvent (9). A flue gas (13) purified of carbon dioxide and carbon dioxide-enriched solvent (11) are formed in the process. Subsequently, in a desorption process (5), the first sub-stream (7) and the second sub-stream (8) of the carbon dioxide-enriched solvent (11) are brought together and carbon dioxide (14) is desorbed through the input of thermal energy (15), carbon dioxide-depleted solvent (9) being formed.

Fig. 1

Description

Method for capturing carbon dioxide and gas turbine plant with carbon dioxide capture

The invention relates to a method for capturing carbon dioxide with a first absorption process, a combustion process, a second absorption process and a desorption process. The invention further relates to a gas turbine plant with a gas turbine, which is connected on the fuel side to a fuel gas line, and the flue gas duct of which is connected to a downstream carbon dioxide capture device.

The combustion of a fossil fuel in fossil fuel-fired power plants for generating electricity produces a carbon dioxide-containing flue gas. To prevent or reduce carbon dioxide emissions, carbon dioxide has to be separated from the flue gases. Various methods are generally known for separating carbon dioxide from a gas mixture.

In particular the absorption-desorption method is commonly used to separate carbon dioxide from a flue gas after a combustion process (Post-Combustion CO2 Capture, Post Cap). On a large industrial scale, in such a method carbon dioxide is scrubbed out of the flue gas with an absorbent at around atmospheric pressure. In a conventional absorption-desorption process the flue gas is brought into contact with a selective solvent as absorbent in an absorption column, the carbon dioxide being absorbed by the solvent. The solvent enriched with carbon dioxide is passed into a desorption column in order to separate the carbon dioxide and regenerate the solvent. The solvent is heated (possibly also depressurized), wherein carbon dioxide is desorbed again and a regenerated solvent is formed. The regenerated solvent is again passed to the absorber column, where it may again absorb carbon dioxide from the carbon dioxide-containing flue gas. Common absorbents display good selectivity and an elevated capacity for the carbon dioxide to

be separated. Particularly suitable absorbents are those which are based on amines, such as for example monoethanolamine. In the chemical industry too, amine solutions are generally used as absorbents.

The Pre-Combustion CO2 Capture (Pre Cap) method, in which a CO shift and physical carbon dioxide scrubbing proceed under elevated pressure (IGCC concept), is commonly used to separate carbon dioxide prior to the combustion process.

When using standard natural gas as combustion fuel for a gas turbine, carbon dioxide is separated from the flue gas preferably after combustion in a standard gas turbine with premix combustion. Standard natural gas is in this case distinguished by a correspondingly high calorific value and a low proportion of inert gases (for example nitrogen or carbon dioxide).

On the other hand, in the case of a "lean" natural gas, which contains an elevated proportion of inert gases, such as for example natural gas with a high carbon dioxide content (e.g. 30 to 70% carbon dioxide content), said gas has first to be conditioned for combustion in a standard gas turbine.

To this end high grade natural gas may be admixed with the lean natural gas, for example, and thus enriched to a methane content which allows combustion in a standard gas turbine. It is also possible to allow combustion of a lean natural gas in a standard gas turbine by means of combustion with oxygen and subsequent condensation of water. However, these variants require high expenditure and additional gases.

It is alternatively possible to adapt the gas turbine specifically to low-calorific, lean natural gas. However, this may entail enormous development expenditure, depending on machine model.

It is therefore an object of the invention to provide a method and a device which on the one hand allows use of a lean natural gas with a standard gas turbine and on the other hand ensures capture of the carbon dioxide arising due to combustion.

The object of the invention is achieved with regard to the method by the features of claim 1.

The invention is based on the idea of firstly subjecting a natural gas with a high carbon dioxide content to a carbon dioxide capture process prior to the combustion process. The carbon dioxide contained in the natural gas is in the process largely absorbed by a solvent as a result of a chemical absorption process. A carbon dioxide-depleted natural gas is thus available for the downstream combustion process. The carbon dioxide arising through the combustion of the natural gas is absorbed in a downstream capture process. The capture process here consists of an absorber, in which the flue gas is scrubbed by a solvent, and a desorber. According to the invention, carbon dioxide-enriched solvent from the absorption process upstream of combustion and that downstream of combustion is then together supplied to the desorber.

The invention thus consists on the one hand in combining an absorber process upstream of the combustion process particularly advantageously with an absorber process downstream of the combustion process. The staged absorption process, which may proceed at different pressures, is additionally particularly advantageously interconnected, such that only one solvent and only one desorption process have to be installed for both absorber processes. The absorption process upstream of the combustion process may also be markedly more compact due to the elevated pressure level.

The invention thus makes it possible to use a standard gas turbine with premix combustion systems even in the presence of a fuel gas or natural gas with a high carbon dioxide content.

In this way lower NOx emissions may be achieved. In combination with capture from the flue gas, a significant reduction in overall emissions may be anticipated. Overall, the invention allows fuel gases or natural gases with a very high carbon dioxide content to be used, with an overall high level of carbon dioxide capture. In this way the capital and operating costs of a corresponding plant may be reduced markedly in comparison with the prior art.

In an advantageous development of the invention the first absorption process upstream of the combustion process is operated at a higher pressure than the second absorption process downstream of the combustion process. In this way the first absorption process may be operated at the delivery pressure of the fuel gas or natural gas, for example as it arrives at the plant after extraction from the gas field. Such gas pressures are preferably between 20 and 30 bar. If the fuel gas or natural gas is at a correspondingly low pressure level, the first absorption process may also be carried out in the low pressure range (at around atmospheric pressure). The fuel gas depleted by the first absorption process must in this case then be compressed to the pressure necessary for the combustion process due to the relatively low mass flow rate. The second absorption process and the desorption process are preferably operated at around atmospheric pressure.

In an advantageous further development of the method according to the invention, the heat needed for the desorption process is provided by the combustion process. To this end heat is removed from the flue gas duct via a heat exchange process and supplied to the desorption process. In this way, the desorption process may sensibly be operated by (surplus) energy available in the plant.

The solvent which leaves the desorption process again in a regenerated state is conveniently subdivided into a first sub-stream, which is supplied to the first absorption process, and

a second sub-stream, which is supplied to the second absorption process.

The method is preferably used in a gas turbine power plant or a gas and steam turbine power plant. In this case, the power plant comprises a gas turbine, a carbon dioxide capture device arranged downstream of the gas turbine and a first absorber arranged upstream of the gas turbine.

The solvent used for absorbing carbon dioxide is preferably an aqueous amino acid salt solution. Other solvents are, however, feasible in principle.

The object of the invention relating to a device is achieved by the features of claim 6.

The invention will be explained in greater detail below with reference to an exemplary embodiment of the method according to the invention.

Fig. 1 shows a method 1 for carbon dioxide capture, and substantially comprises a first absorption process 2, a combustion process 3, a second absorption process 4 and a desorption process 5. The first absorption process 2 comprises a first absorber 24 to which a natural gas 6 with a high carbon dioxide content is supplied via a fuel gas line 22. A solvent 9 is additionally supplied to the first absorber 24 via a first sub-stream 7. The carbon dioxide from the natural gas 6 is absorbed under pressure by the solvent 9, such that on the one hand a carbon dioxide-depleted natural gas 10 leaves the first absorption process under high pressure via the fuel gas line 22, and on the other hand a carbon dioxide-enriched solvent 11 is discharged.

The carbon dioxide-depleted natural gas 10 is then supplied to the combustion process 3, which is a component part of a gas turbine plant 20 and comprises a gas turbine 21. Combustion of

on the other hand a carbon dioxide-enriched solvent 11 is discharged.

The carbon dioxide-depleted natural gas 10 is then supplied to the combustion process 3, which is a component part of a gas turbine plant 20 and comprises a gas turbine 21. Combustion of the carbon dioxide-depleted natural gas 10 results in a carbon dioxide-containing flue gas 12, which is supplied via a flue gas duct 28 to the second absorption process 4. A steam generation process may be connected into the flue gas duct 28, which process generates steam for a steam turbine.

The second absorption process 4 comprises a second absorber 26, into which the carbon dioxide-containing flue gas 12 is fed together with a solvent 9, via a second sub-stream 8. The carbon dioxide from the carbon dioxide-containing flue gas 12 is absorbed by the solvent 9 substantially under atmospheric pressure, such that on the one hand a flue gas 13 largely purified of carbon dioxide and on the other hand a carbon dioxide-enriched solvent 11 are discharged from the second absorption process 4.

The carbon dioxide-enriched solvent 11 from the first absorption process 2 and the second absorption process 4 is supplied together to the desorption process 5. The desorption process comprises a desorber 25, in which the carbon dioxide-enriched solvent is decocted, carbon dioxide being desorbed. A separated carbon dioxide 14 and a solvent 9 are discharged from the desorption process, the solvent being regenerated.

The thermal energy 15 for heating the desorber 25 is removed from the hot carbon dioxide-containing flue gas 12 via a line 30. To this end the thermal energy is supplied to the desorber by heat exchange via a reboiler 29.

The second absorption process 4 arranged downstream of the combustion process 3 and the desorption process 5 here by themselves form

Patent claims

1. A method for capturing carbon dioxide (1), in which
   - in a first absorption process (2) carbon dioxide is absorbed by bringing a supplied carbon dioxide-containing natural gas (6) into contact with a first sub-stream (7) of a solvent (9), a carbon dioxide-depleted natural gas (10) and carbon dioxide-enriched solvent (11) being formed,
   - in a combustion process (3) of a gas turbine (21) the carbon dioxide-depleted natural gas (10) is combusted, a carbon dioxide-containing flue gas (12) being formed,
   - in a second absorption process (4) carbon dioxide is absorbed by bringing the carbon dioxide-containing flue gas (12) into contact with a second sub-stream (8) of the solvent (9), a flue gas (13) purified of carbon dioxide and carbon dioxide-enriched solvent (11) being formed,
   - the first absorption process (2) being carried out at a first pressure (P1), and the pressure (P1) corresponding to the pressure of the supplied carbon dioxide-containing natural gas (6), and being set higher than a pressure (P2) set in the second absorption process (4),
   - in a desorption process (5) the first sub-stream (7) and the second sub-stream (8) of the carbon dioxide-enriched solvent (11) are brought together and carbon dioxide (14) is desorbed through the input of thermal energy (15), carbon dioxide-depleted solvent (9) being formed.

2. The method as claimed in claim 1, in which the thermal energy (15) for the desorption process (5) is extracted from the carbon dioxide-containing flue gas (12).

3. The method as claimed in one of claims 1 or 2, in which the solvent (9) is subdivided into a first sub-stream (7) and a second sub-stream (8), the first sub-stream (7)

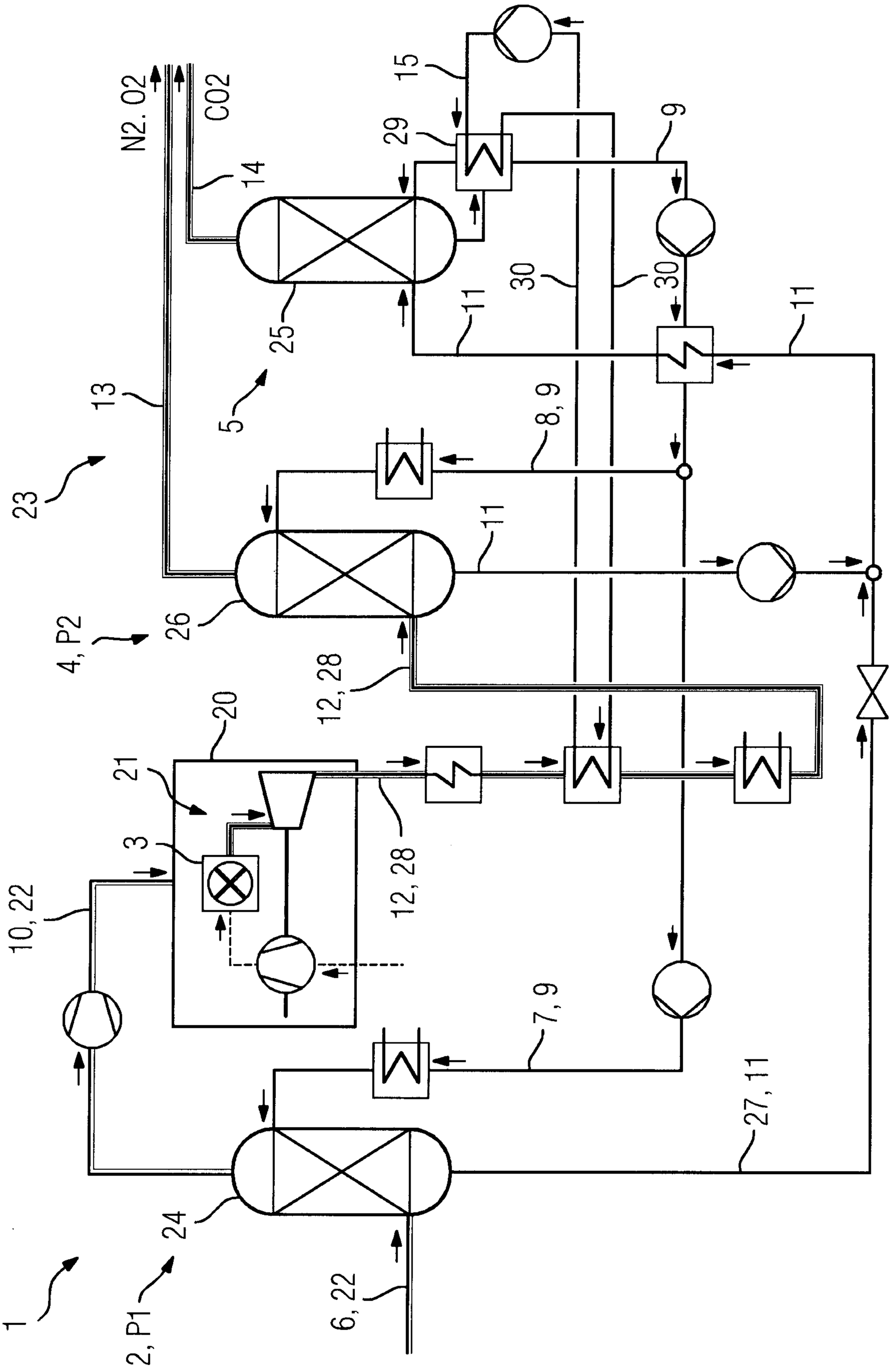
being supplied to the first absorption process (2) and the second sub-stream (8) being supplied to the second absorption process (4).

4. The method as claimed in one of claims 1 to 3, characterized by use in a gas turbine power plant with a gas turbine (21), a downstream carbon dioxide capture device (23), and a first absorber (24) arranged upstream of the gas turbine.

5. A gas turbine plant (20) with a gas turbine (21), which is connected on the fuel side to a fuel gas line (22), in particular to a natural gas line, and the flue gas duct (28) of which is connected to a downstream carbon dioxide capture device (23), the carbon dioxide capture device (23) comprising a second absorber (26) and a desorber (25),
characterized in that a first absorber (24) is connected into the fuel gas line (22), which first absorber is connected to the desorber (25) via an absorbent line (27), and the first absorber (24) being a high pressure absorber, which is designed for the pressure of the natural gas line (22), and the second absorber (26) being a low pressure absorber, which is designed for around atmospheric pressure.

6. The gas turbine plant (20) as claimed in claim 5, characterized in that the desorber (25) comprises a reboiler (29), and in that a heat exchanger is connected into the flue gas duct, which heat exchanger is connected to the reboiler (29) via a line (30), such that heat from the flue gas duct (28) may be transferred into the desorber (25).

7. A gas and steam turbine plant comprising a gas turbine plant (20) as claimed in one of claims 5 or 6, with a boiler arranged downstream of the gas turbine (21) on the flue gas side and a steam turbine driven by means of the boiler.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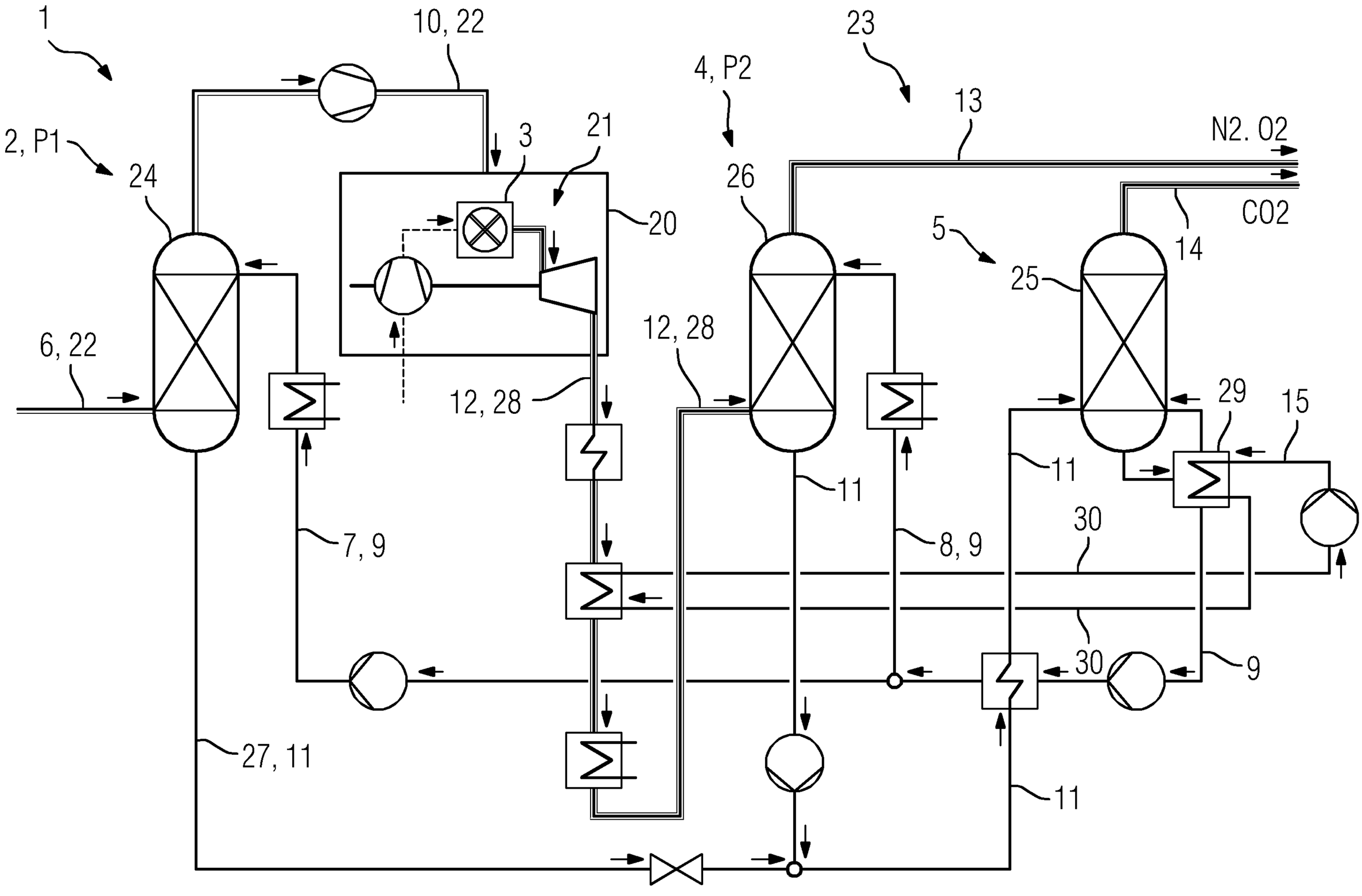
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