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(54) **METHOD AND FOSSIL-FUEL-FIRED POWER PLANT FOR RECOVERING A CONDENSATE**

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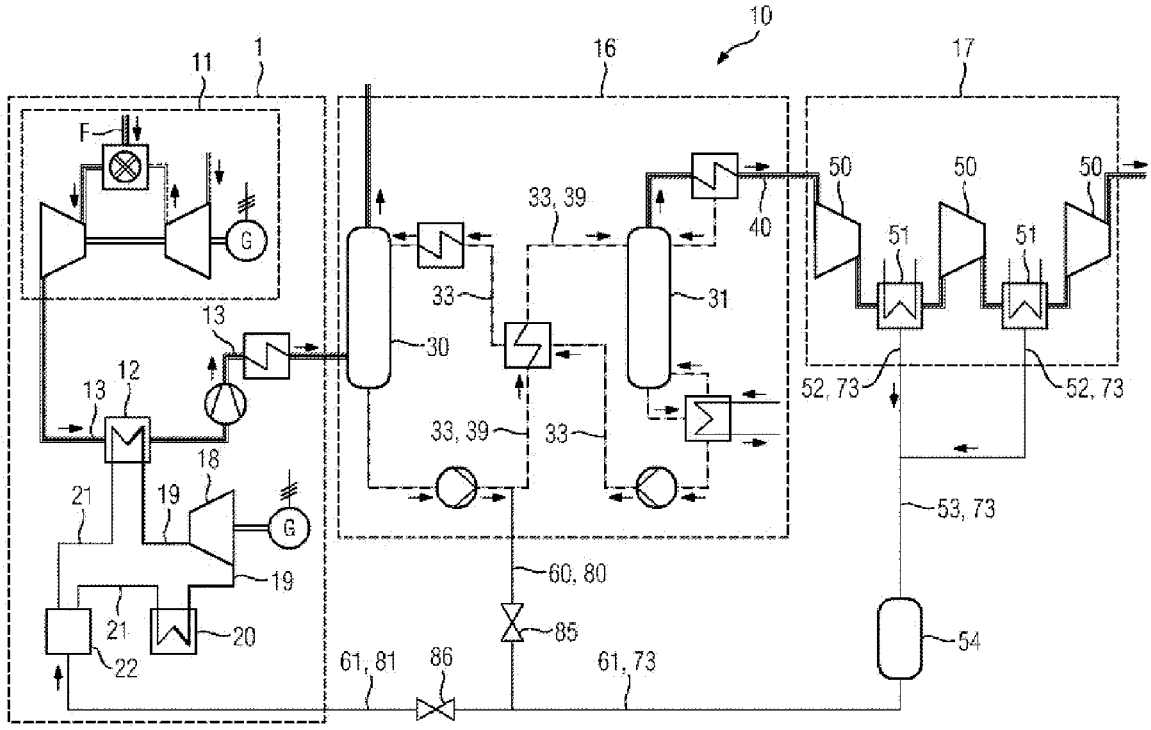
(57) **ABSTRACT**

A fossil-fuel-fired power plant, having a combustion device, a CO_2 separation device, which is arranged downstream of the fossil-fuel-fired power plant, for removing CO_2, and a CO_2 compressor station, which is arranged downstream of the CO_2 separation device and which has a number of compressor stages and coolers for intermediate cooling is provided. The coolers are connected to the CO_2 separation device or the fossil-fuel-fired power plant by means of a condensate line in order to recover condensate. A method for carrying out the condensate recovery is also provided.



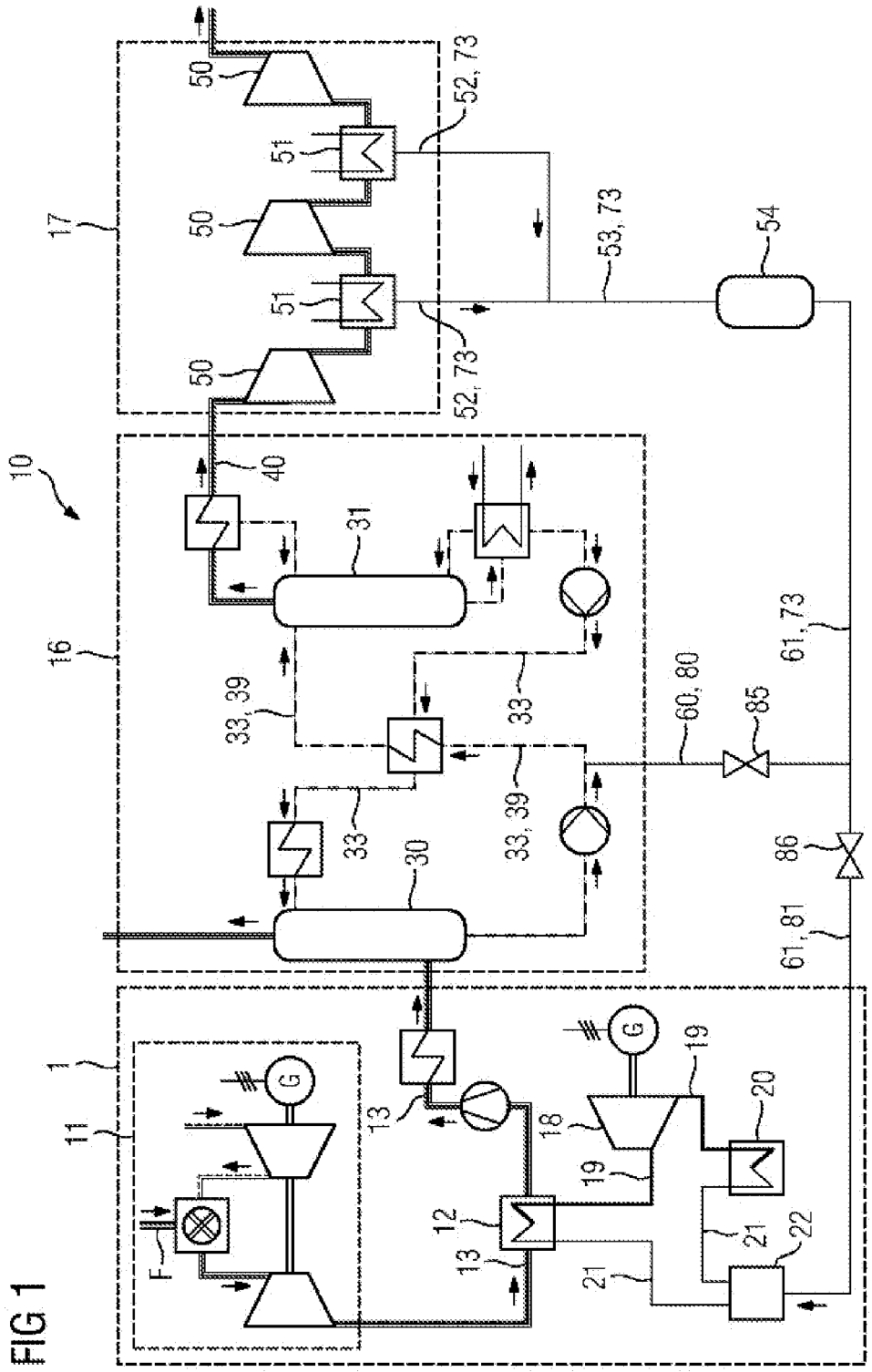

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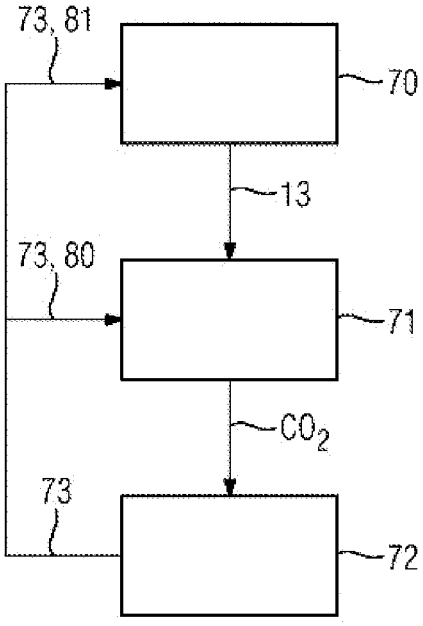
FIG 1

FIG 2



METHOD AND FOSSIL-FUEL-FIRED POWER PLANT FOR RECOVERING A CONDENSATE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is the U.S. National Stage of International Application No. PCT/EP2012/064522 filed Jul. 24, 2012, and claims the benefit thereof. The International Application claims the benefit of European Application No. EP11175948 filed Jul. 29, 2011. All of the applications are incorporated by reference herein in their entirety.

FIELD OF INVENTION

[0002] The present invention relates to a fossil-fuel fired power plant for recovering a condensate and methods therefor.

BACKGROUND OF INVENTION

[0003] In fossil-fired power plants for generating electric energy, a flue gas containing carbon dioxide is produced as a result of the combustion of a fossil fuel. For avoiding or for reducing carbon dioxide emissions, carbon dioxide must be separated from the flue gases. For separating carbon dioxide from a gas mixture, different methods are universally known. In particular, for separating carbon dioxide from a flue gas after a combustion process, the method of absorption-desorption is common. On a commercial scale, carbon dioxide is washed out of the flue gas with a solvent (CO_2 capture process) in this case.

[0004] Common absorption mediums are aqueous solutions of a wash-active additive, such as monoethanolamine (MEA), amino-acid salts or potash. These wash-active additives feature a good selectivity and a high capacity for carbon dioxide (CO_2).

[0005] During operation of the CO_2 capture process, however, some of the water invariably continuously evaporates. The water vapor is discharged from the absorber together with the flue gas which is cleaned of CO_2. As a result of the discharging of water from the absorption medium circuit, the dilution ratio between water and the wash-active additives, such as amines, amino-acid salts or potash, is altered. Therefore, makeup water must be fed continuously to the absorption medium circuit in order to compensate for the water which is discharged as a result of evaporation.

[0006] A power plant and method in which the condensate occurring in the compression of flue gas is returned back to the water-steam cycle of the power plant is already known from WO 2011006882 A2. A CO_2 separation apparatus, in which the separated CO_2 is compressed, and the condensate thereby occurring is discharged, is known from U.S. Pat. No. 5,025,631 A. WO 2011003892 A2 discloses a method and a power plant comprising CO_2 separation with heat recovery, in which the condensate from the CO_2 separation apparatus is separated and discharged.

[0007] For the feed of makeup water, a demineralized water (demin-water) is frequently used. For provision of this water, high costs are partly incurred.

[0008] In power plants which are retrofitted with CO_2 separation apparatus a demin-water treatment plant must also be provided at the same time, bringing with it high investment and operating costs. Such demin-water treatment plants are even already installed in a required volume in power plants which are prepared as a capture-ready plant just for a later retrofit or installation of a CO_2 separation process. In power plants which are still not prepared as being capture-ready, it is necessary to extend the existing demin-water treatment plant of the power plant during the process of retrofitting CO_2 separation apparatus.

SUMMARY OF INVENTION

[0009] It is therefore an object herein to provide a fossil-fired power plant by which the costs for the installation and the operation of a demin-water treatment plant can be reduced despite installation of CO_2 separation apparatus which is connected to the power plant. It is also an object herein to provide a method for recovery of condensate, as a result of which the demin-water treatment plant of a power plant with associated CO_2 separation apparatus can be relieved of load.

[0010] These objects are achieved by means of a fossil-fired power plant according to embodiments described herein. The fossil-fired power plant accordingly comprises fossil-fired combustion apparatus in which as a result of the combustion of fossil fuels a flue gas containing CO_2 is formed. Connected downstream to the power plant is CO_2 separation apparatus for separating CO_2 from the flue gas. This comprises an absorber and a desorber which are connected into an absorption medium circuit. For liquefying the CO_2 which is separated in the CO_2 separation apparatus, a CO_2 compressor station, which is connected to the desorber for the discharge of separated CO_2, is connected downstream to the CO_2 separation apparatus. The compressor station in this case comprises a compressor with a number of compressor stages, wherein a cooler for cooling the compressed CO_2 is connected between the compressor stages in each case. The condensate, which is formed during the cooling of the compressed CO_2, is now fed back via a condensate line to the CO_2 separation apparatus and/or to the fossil-fired power plant.

[0011] An aspect in this case utilizes the fact that the condensate, which accumulates during compression of the CO_2, has high quality. Further use of the condensate is also particularly advantageous because of this since during the compression of the CO_2 large volumes of condensate accumulate. Filters or additional separators can additionally be connected into the condensate line in this case in order to filter out residues which are present in the condensate.

[0012] As a result of the connection according to the invention of the cooler of the CO_2 compressor via a condensate line to the CO^2 separation apparatus or to the fossil-fired power plant, in the case of a new construction of the power plant the demin-water treatment plant can be of a correspondingly smaller construction since it has to provide only a significantly reduced volume of demin-water for the CO_2 separation apparatus.

[0013] In a particularly favorable development, the condensate line is connected to a demin-water treatment plant of the fossil-fired power plant for providing demineralized water so that water which condenses during the intercooling of the CO_2 can be made available to the treatment plant as prepurified water. In the treatment plant, the condensate in this case is additionally freed of residual impurities, especially such as residues of active additives or CO_2.

[0014] In a further preferred embodiment, the condensate line is connected directly to the absorption medium circuit of the CO_2 separation apparatus so that water which condenses during the intercooling of the CO_2 can be provided directly as makeup water flow for the CO_2 separation apparatus. It is particularly advantageous in this case if a reservoir for con-

densate is connected into the condensate line so that the condensate can be temporarily stored. Furthermore, a control device can also be connected into the condensate line so that the condensate can be fed to the CO_2 separation apparatus in a specifically controlled manner.

[0015] Alternatively, or in combination with the connection of the condensate line to the CO_2 separation apparatus, the condensate line can be connected to a water-steam cycle of the fossil-fired power plant so that water which condenses during the intercooling of the CO_2 can be provided as feed water for the power plant. Also possible in this case is a temporary storage reservoir, or a control process, which correspondingly introduces condensate into the water-steam cycle depending upon the feed water which is to be fed. The introduction of condensate into the condenser of the water-steam cycle is advantageous in this case since as a result of the condensate the condensing in the condenser is benefited. Also worthwhile is a control system which, depending upon the requirement for water which is to be fed, directs or distributes the condensate either as makeup water to the CO_2 separation process or as feed water to the water-steam cycle.

[0016] The condensate can also be advantageously provided as process water for the power plant. In the conventional power plant for power generation, there is a requirement for demin-water at different points for additional processes. To this end, it is provided that the condensate line is connected to a process water line of the fossil-fired power plant so that the water which condenses during the intercooling of the CO_2 can be fed as condensate to various processes.

[0017] The object of the invention which is directed towards a method is achieved by means of the features described herein. For recovery of condensate and for relieving the load of a water treatment plant, which is a component part of a fossil-fired power plant process, condensate from the intercooling of a compression of CO_2 is fed back again to the CO_2 separation process, which is connected downstream to the power plant, or to the power plant process.

[0018] The condensate is expediently fed in this case as prepurified water to a treatment process for demineralized water (demin-water treatment plant) which covers the power plant process. As a result, the water treatment process is significantly relieved of load since less mineralized fresh water has to be introduced into the process from outside.

[0019] It is also particularly advantageous if the condensate is fed as makeup water to the CO_2 separation process of a water circuit which includes an absorption and desorption process. Alternatively or in addition to this, it is also advantageous if the condensate is fed as feed water to a water-steam cycle of the power plant process. Also alternatively or in addition to feed back as makeup water or feed water, the condensate can also be fed as process water to a process which is connected to the power plant process.

[0020] The method is particularly advantageously suitable in combination with an amino-acid salt as wash-active substance since the amino-acid salt has no appreciable vapor pressure in comparison to amines and therefore cannot be discharged either from the CO_2 separation process by way of the condensate. The condensate therefore has a particularly high degree of purity when using amino-acid salts since it is free of wash-active substances or residues thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] Exemplary embodiments of the invention are explained in more detail in the following text with reference to figures. In the drawing:

[0022] FIG. **1** shows a fossil-fired power plant with a condensate feedback line into the absorption medium circuit and into the water-steam cycle of the power plant,

[0023] FIG. **2** shows a method for relieving the load of a water treatment plant of a fossil-fired power plant with CO_2 separation apparatus.

DETAILED DESCRIPTION OF INVENTION

[0024] FIG. **1** shows a fossil-fired power plant **10**, with a gas turbine plant as combustion apparatus **11**, a heat recovery steam generator **12** which, via a flue gas duct **13**, is connected downstream to the gas turbine of the combustion apparatus **11**, a condenser **20**, a demin-water treatment plant **22**, CO_2 separation apparatus **16** which is connected into the flue gas duct **13**, and a compressor **17**, having a number of compressor stages and intercooling stages **50**, **51**, which is connected downstream to the CO_2 separation apparatus **16**.

[0025] In the gas turbine plant of the combustion apparatus **11**, a fossil fuel is combusted, wherein flue gas containing CO_2 is formed. The flue gas is fed to the heat recovery steam generator **12** via a flue gas duct **13** for producing steam **19**. The steam **19** is fed in turn to a steam turbine plant **18**, which is not shown in more detail here, where it is expanded, is then fed to a condenser **20**, and expanded to form feed water **21**. After the condensing of the steam **19** in the condenser, the feed water **21** is fed to a demin-water treatment plant **22**. The demin-water treatment plant **22** is connected in turn to the heat recovery steam generator **12**, via a feed-water line **21**, for feedback of the feed water. The line for the steam **19** and the line for the feed water **21** form a water-steam cycle.

[0026] The heat recovery steam generator **12** is connected to the CO_2 separation apparatus **16** for discharging the flue gas **13**. The CO_2 separation apparatus **16** in essence comprises an absorber **30** and a desorber **31** which are connected into an absorption medium circuit **33**. Provision is made in the absorption medium circuit **33** for various heat exchangers, valves and pumps, which are not additionally elaborated upon. The CO_2 separation apparatus **16** releases gaseous CO_2 **40**, largely freed of other constituents, which is fed to the compressor **17**.

[0027] The compressor **17** comprises a number of compressor stages **50** and intercoolers, or cooler stages **51**, which are arranged between the compressor stages. The intercoolers **51** have a condensate outlet **52** which converge in a condensate drain line **53**. The condensate drain line **53** is connected to a condensate storage reservoir **54**.

[0028] The storage reservoir **54** is connected in turn via a condensate line **60** to the absorption medium circuit **33**, preferably to the line for the loaded absorption medium **39**. A control valve **85**, via which the volume of condensate which is supplied can be adjusted, is connected into the condensate line **60** in this case. Also connected to the storage reservoir **54** is a condensate line **61** which connects the storage reservoir **54** to the demin-water treatment plant **22**. A control valve **86** for controlling the condensate flow is also connected into the condensate line **61**. Pumps or discharge valves, which can also be connected into the condensate lines **60**, **61**, are not shown.

[0029] Also not shown is a further condensate line which connects the storage reservoir **54** to the water-steam cycle of the steam turbine plant **18**.

[0030] FIG. **2** shows a method for relieving the load of a water treatment plant of a fossil-fired power plant with CO_2 separation apparatus, comprising a power plant process **70**, a CO_2 separation process **71** which is connected downstream to the power plant process **70**, and a compressor process **72** which is connected downstream to the CO_2 separation process. In the power plant process **70**, flue gas **13** is produced and fed to the CO_2 separation process **71** for separation. In the CO_2 separation process, CO_2 is separated from the flue gas **13**. The separated, gaseous CO_2 is subsequently fed to the compressor process **72** where it is compressed in a plurality of process stages, this not being shown in more detail here, however. Cooling of the CO_2 is carried out between the compressor stages, wherein a condensate **73** is formed. The condensate is now fed back as makeup water **80** to the CO_2 separation process **71** and alternatively to this, or at the same time, fed back again into the power plant process **70** as feed water **81**. The makeup water **80** in this case is preferably introduced into the flow with loaded absorption medium. The feed water **81** is preferably introduced into the condenser or into a water treatment plant which includes the power plant.

1-10. (canceled)

11. A fossil-fired power plant comprising:

a fossil-fired combustion apparatus with separation of flue gas,

a CO_2 separation apparatus, connected downstream to the fossil-fired power plant, for separating CO_2 from the flue gas, comprising an absorber and a desorber which are connected into an absorption medium circuit, and

a CO_2 compressor station, connected downstream to the CO_2 separation apparatus and connected to the desorber for discharging separated CO_2, and which for liquefying the separated CO_2 comprises a compressor with a number of compressor stages,

wherein a cooler, or a plurality of coolers, is or are connected between the compressor stages for the intercooling of the compressed CO_2, and

wherein the cooler is connected via a condensate line to the absorption medium circuit of the CO_2 separation apparatus so that water which condenses during the intercooling of the CO_2 can be provided as makeup water flow for the CO_2 separation apparatus.

12. A fossil-fired power plant comprising:

a fossil-fired combustion apparatus with separation of flue gas,

a CO_2 separation apparatus, connected downstream to the fossil-fired power plant, for separating CO_2 from the flue gas, comprising an absorber and a desorber which are connected into an absorption medium circuit, and

a CO_2 compressor station, connected downstream to the CO_2 separation apparatus and connected to the desorber for discharging separated CO_2, and which for liquefying the separated CO_2 comprises a compressor with a number of compressor stages,

wherein a cooler, or a plurality of coolers, is or are connected between the compressor stages for the intercooling of the compressed CO_2, and

wherein the cooler is connected via a condensate line to a treatment plant of the fossil-fired power plant for providing demineralized water so that water which condenses during the intercooling of the CO_2 can be made available to the treatment plant as prepurified water.

13. A method for the recovery of condensate, which is a constituent of a fossil-fired power plant process, to which a CO_2 separation process is connected downstream, wherein a compressor process is connected downstream to the CO_2 separation process and comprises a number of process stages between which a cooling process is connected in each case, comprising:

extracting condensate from the cooling processes, and

feeding the extracted condensate as prepurified water to a treatment process for demineralized water which comprises the power plant process.

14. A method for the recovery of condensate, which is a constituent of a fossil-fired power plant process, to which a CO_2 separation process is connected downstream, wherein a compressor process is connected downstream to the CO_2 separation process and comprises a number of process stages between which a cooling process is connected in each case, comprising:

extracting condensate from the cooling processes, and

feeding the extracted condensate as makeup water to the CO_2 separation process of a water circuit which includes an absorption and desorption process.

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