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(54) **METHOD FOR TREATING FLUE GASES FROM THE COMBUSTION OF FUELS AND INCINERATION PLANT**

(57) The invention relates to a Method for the combustion of fuels, comprising the following steps:
a) Combusting the fuel in a combustion apparatus (2, 18), wherein a combustion gas is provided to the combustion process,
b) Treating flue gases from the combustion process in one flue gas treatment unit or in multiple flue gas treatment units (3, 4) downstream of the combustion apparatus (2, 18),
c) Providing an operating gas to at least one operating gas inlet (13) of at least one flue gas treatment unit (3, 4) and/or to at least one operating gas inlet (13) of the combustion apparatus (2, 18), wherein the operating gas comprises at least 10 Vol-% carbon dioxide (CO_2).

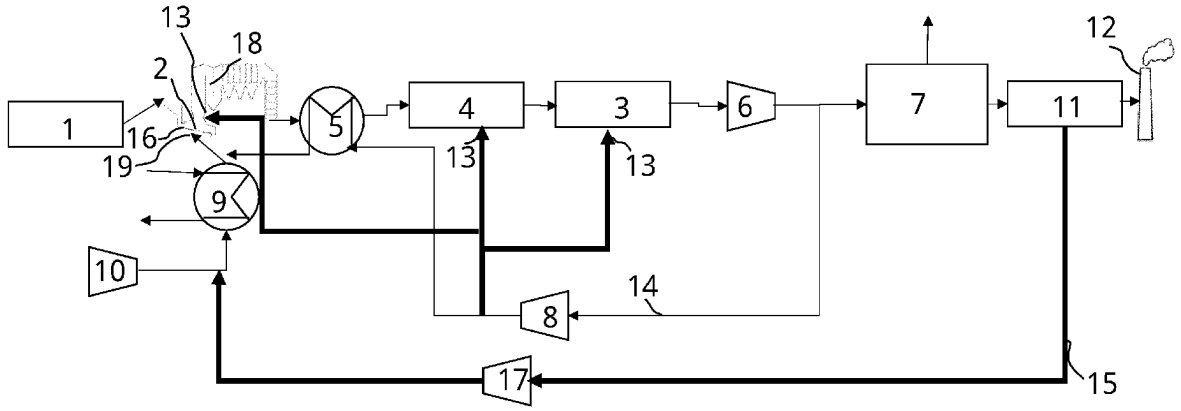

Fig. 1

EP 4 495 480 A1

Description

[0001] The present invention relates to a method for treating flue gases from the combustion of fuels and to an incineration plant. The fuel is in particular solid fuel. The invention in particular refers to the combustion of substitute fuels such as waste, biomass or sewage sludge.

[0002] The incineration plant comprises a combustion apparatus with a combustion chamber, in which the fuel is combusted. The combustion chamber may be embodied as fluidizing bed combustor, to which a primary combustion gas is provided in order to fluidize the preferably solid fuel. The fluidized bed combustor may be operated as stationary, bubbling or circulating fluidized bed. A secondary or even tertiary combustion gas may be provided to the fluidized bed.

[0003] In an alternative and preferred embodiment, a combustion grate is arranged within the combustion chamber to transport the solid fuel from a fuel inlet to an ash outlet through the combustion chamber. For example, the combustion grate may be embodied as reciprocating grate, as vibrating grate or as roller grate. When the combustion chamber comprises a combustion grate, a primary combustion gas is usually provided from below the combustion grate so that the fuel on top of the combustion grate is combusted with the primary combustion gas. Additionally, a secondary combustion gas may be provided for example by nozzles to the combustion chamber above the combustion grate. Furthermore, a tertiary combustion gas may be provided to the flue gases within the combustion chamber or to an pass downstream of the combustion chamber. The (primary, secondary and/or tertiary) combustion gas comprises oxygen and is used to supply oxygen for the combustion process.

[0004] For example, at least one pass may be arranged downstream of the combustion chamber extending vertically or horizontally as part of the combustion apparatus, wherein the flue gases flow from the combustion chamber through the at least one pass to heat a heat recovery steam generator. In particular, two, three or more passes may be embodied.

[0005] The walls of the combustion chamber and/or the pass(es) are usually equipped with heat exchangers (i.e. tubes), wherein the heat exchange medium of the heat exchangers is in particular provided to one common boiler drum. Also, heat exchanger bundles for feed water preheating and evaporation as well as steam superheating may be embodied as part of the heat recovery steam generator. The pass(es) and the heat exchanger(s) and the heat recovery steam generator, which are also referred to as boiler, are considered part of the combustion apparatus.

[0006] For example, a particle separator may be arranged downstream of the combustion chamber, in order to separate solid material from the flue gases, which is in particular necessary, when a fluidized bed is produced in the combustion chamber. Furthermore, the flue gases from the combustion in the combustion chamber may be provided to at least one flue gas treatment unit downstream of the combustion apparatus. Accordingly, a flue gas outlet of the combustion apparatus is connected to an flue gas inlet of the flue gas treatment unit, wherein multiple flue gas treatment units may be arranged behind each others, so that the flue gases from the combustion chamber pass through the multiple flue gas treatment units.

[0007] One flue gas treatment unit may be embodied as dedusting unit, with which dust can be removed from the flue gases.

[0008] Alternatively or additionally, a cleaning unit for removing acid gases may be embodied, with which for example SO_2, HCl and/or HF can be removed from the flue gases. A further treatment unit may be embodied for denitrification (such as SCR or SNCR) of the flue gases.

[0009] A chimney/stack may be arranged downstream of the flue gas treatment unit(s).

[0010] As it is the general intention to reduce the carbon dioxide emission, a carbon capture device may be arranged downstream of the flue gas treatment unit(s) and upstream of the chimney/stack. With such a carbon capture device, carbon dioxide can be removed from the flue gases and stored or used in a generally known manner.

[0011] Such a carbon capture device can be operated more efficiently the higher the carbon dioxide concentration of the flue gases introduced in the carbon capture device. In order to raise the carbon dioxide concentration of the flue gases, the nitrogen concentration of the combustion gas provided to the combustion chamber can be lowered, so that the carbon dioxide concentration of the resulting flue gas is less diluted. The nitrogen concentration of the combustion gas can be lowered, if (pure) oxygen is provided to ambient air used as combustion gas or if pure oxygen is mixed to an alternative gas source containing less nitrogen than ambient air. Accordingly, the incineration plant may comprise an oxygen source, which is connected to a combustion gas inlet of the combustion chamber, so that a combustion gas having a higher oxygen concentration than ambient air is provided to the combustion chamber and/or oxygen is mixed into another source of gas containing less nitrogen than ambient air. Such a source for (pure) oxygen may be embodied by a respective storage vessel for pure oxygen, by an electrolysis unit or by an air separation unit.

[0012] Nevertheless, if the oxygen concentration of the combustion gas is raised, also the combustion temperature will raise. Accordingly, in order to keep the combustion temperature in a desired range, flue gases, in particular withdrawn from downstream of at least one and preferably downstream of one or more and preferably downstream of (all) the flue gas treatment unit(s), are provided to the combustion gas. Accordingly, the incineration plant according to the present invention may comprise a recirculation line for withdrawing treated flue gases from downstream of a flue gas treatment unit(s),

wherein the recirculation line is at least indirectly connected to a combustion gas inlet of the combustion chamber. This method is also known as exhaust gas recirculation. Combusting the fuel with a combustion gas with a high oxygen concentration (and a minimal nitrogen concentration) is known as oxyfuel combustion process.

[0013] Accordingly, if the combustion gas provided to the combustion chamber is mainly composed of oxygen and carbon dioxide, the carbon dioxide concentration of the flue gases is comparatively high at the outlet of the combustion chamber, so that principally the carbon capture device should be able to be run efficiently. Nevertheless, it has been noticed that the carbon dioxide (CO_2) concentration of the flue gases may decrease from the combustion chamber towards the inlet of the carbon capture device downstream of the flue gas treatment unit(s).

[0014] Accordingly, it is an object of the present invention to provide a method for the combustion of fuels and an incineration plant, with which the efficiency of a carbon capture device can be raised.

[0015] One possible solution is given by a method and an incineration plant with the features of the respective independent claim. Further solutions and preferred embodiments are described in the dependent claims and in the preceding and following description, wherein single features of the preferred embodiments may be combined in a technically meaningful manner. Features disclosed with regard to the method may be applied to the incineration plant and vice versa.

[0016] The object is in particular solved by a method for the combustion of fuels, in particular of solid fuels and preferably substitute fuels such as waste, biomass or sludge, comprising the following steps:

a) Combusting the fuel in a combustion apparatus, wherein a combustion gas is provided to the combustion process,

b) Treating flue gases from the combustion process in one flue gas treatment unit or in multiple flue gas treatment units downstream of the combustion apparatus,

c) Providing an operating gas to at least one operating gas inlet of at least one flue gas treatment unit and/or to at least one operating gas inlet of the combustion apparatus, wherein

the operating gas comprises at least 10 Vol-% carbon dioxide (CO_2).

[0017] The object is also solved by an incineration plant having a combustion apparatus, wherein the combustion apparatus comprises at least one combustion gas inlet for a combustion gas, the incineration plant further having one flue gas treatment unit or multiple flue gas treatment units downstream of the combustion apparatus, wherein the combustion apparatus and/or at least one flue gas treatment unit comprises at least one operating gas inlet for an operating gas, wherein at least one operating gas inlet is connected to a source of carbon dioxide (CO_2).

[0018] Accordingly, the present invention is directed to such components of the combustion apparatus, which receive an operating gas eventually in addition to a combustion gas. The present invention is also directed to such flue gas treatment units in an incineration plant, which receive in addition to the flue gases from the combustion process an operating gas.

[0019] Such an operating gas can function as a medium to support the treatment function of the flue gas treatment unit, as a medium to cool, clean and/or maintain the respective component of the combustion apparatus or of the flue gas treatment unit or as sealing gas, or the like.

[0020] For example, the operating gas may be used within the combustion apparatus as cooling gas for auxiliary burners, as sealing and cooling gas in boiler cleaning systems (such as water spraying system, rapping device, soot blower) and as transporting medium for additive injection. Components of a combustion apparatus which are operated by an operating gas eventually in addition to the combustions gases or additives are principally known. In contrast to the present invention, the known components of a combustion apparatus are operated with ambient air as operating gas, so that the composition of the flue gases is altered, thereby eventually lowering the carbon dioxide concentration of the flue gases.

[0021] Additionally or alternatively, the operating gas may be used within a flue gas treatment unit as sealing gas to seal the flue gases within the flue gas treatment unit against for example the surrounding, as transporting medium for transporting additives needed to operate the flue gas treatment unit, as fluidizing gas for operating a fluidizing gutter and/or as cleaning gas for cleaning a filter of the flue gas treatment unit. Flue gas treatment units which are operated by an operating gas in addition to the flue gases are principally known. In contrast to the present invention, the known flue gas treatment units are operated with ambient air, whereby ambient air is mixed to the to be treated flue gases, so that the composition of the flue gases is altered, thereby eventually lowering the carbon dioxide concentration of the flue gases within the flue gas treatment unit.

[0022] According to the present invention, the flue gas treatment unit(s) of an incineration plant and/or the component(s) of the combustion apparatus is/are operated with an operating gas which comprises at least 10 Vol-%, preferably at least 20 Vol-%, preferably at least 50 Vol-% and most preferably at least 80 Vol-% carbon dioxide (CO_2). By operating the flue gas treatment unit(s) and/or the component(s) of the combustion apparatus with an operating gas having a high carbon dioxide concentration, the carbon dioxide concentration of the flue gases may be less reduced or even raised. Accordingly, a carbon capture device arranged downstream of the flue gas treatment unit(s) can be operated more efficiently

(greater capture and/or less energy consumption), so that the carbon dioxide emission of the incineration plant is reduced.

[0023] The operating gas source may be any source of gas, which gas has at least 10 Vol-% of carbon dioxide.

[0024] Preferably, the operating gas consists of the (treated) flue gases or comprises the (treated) flue gases as source for the carbon dioxide. Accordingly, it is suggested according to an embodiment of the invention that a recirculation line for withdrawing treated flue gases from downstream of one of the flue gas treatment unit(s) is connected to at least one operating gas inlet of the at least one treatment unit and/or to at least one operating gas inlet of the at least one component of the combustion apparatus, so that flue gases are withdrawn from downstream of one of the flue gas treatment unit(s) and provided at least as part of the operating gas to the operating gas inlet(s). Preferably, the operating gas provided to the operating gas inlet(s) consists completely of flue gases.

[0025] In one embodiment, the recirculation line may be connected directly downstream to the flue gas treatment unit to which operating gas inlet the recirculation line is connected to. Alternatively, the recirculation line may be connected downstream of another, in particular of the last flue gas treatment unit, wherein at least a part of the treated flue gases are recirculated to the component(s) of the combustion apparatus, to one flue gas treatment unit or to all flue gas treatment units. The recirculated (treated) flue gases may therefore be provided to the component(s) of the combustion apparatus, to one or to all of the flue gas treatment unit(s), which are using an operating gas for operation.

[0026] Although less energy-efficient, the recirculation line may also be connected to the carbon capture device, so that the carbon dioxide removed from the flue gases by the carbon capture device may be recirculated to the component(s) of the combustion apparatus and/or to the flue gas treatment unit(s).

[0027] In a preferred embodiment, the incineration plant comprises an air separation unit, with which oxygen is provided at least as part of the combustion gas to the combustion chamber. In this case it is suggested, that flue gases from downstream of the carbon capture device are completely or partially provided to the inlet of the air separation device. This way, the emission from the incineration plant can be further reduced and the efficiency of the air separation unit is increased due to the comparatively high (in comparison to the oxygen content of ambient air) oxygen content of the flue gas treated in the carbon capture device.

[0028] The invention and the technical background will now be described with respect to the figure, which schematically shows an exemplary incineration plant.

[0029] The incineration plant comprises a combustion chamber 2 and a boiler 18 as elements of a combustion apparatus, wherein the combustion chamber 2 has a combustion grate 16 at its bottom, with which a substitute fuel 1 can be transported through the combustion chamber 2. The boiler 18 comprises multiple passes. Combustion gas can be provided by combustion gas blower 10 as primary combustion gas through a combustion gas inlet 19 to the bottom of the combustion chamber 2 and as secondary/tertiary combustion air above the combustion chamber 2, so that the substitute fuel on top of the grate 16 is combusted with the combustion gas. The combustion gas may be preheated by combustion gas preheater 9.

[0030] The flue gases from the combustion chamber 2 are guided through, the boiler 18, a heat exchanger 5, a separator 4 for acid gases as a first flue gas treatment unit and a dedusting unit 3 as a second flue gas treatment unit. Depending on flue gas treatment arrangement installed a blower 6 is required to overcome the pressure loss of the system and to transport the flue gases through a carbon capture device 7, in which carbon dioxide is separated from the flue gases, wherein the remaining flue gases are guided towards a stack 12.

[0031] Furthermore, the incineration plant comprises a recirculation line 14, with which flue gases are withdrawn downstream from the dedusting unit 3 and upstream of carbon capture device 7, wherein at least part of the withdrawn flue gases are provided to operating gas inlets 13 of the dedusting unit 3, to operating gas inlets 13 of the separator for acid gases 4 and to operating gas inlets 13 of the combustion apparatus. The remaining withdrawn flue gases are provided towards the combustion gas providing line, so that the withdrawn flue gases are provided as part of the combustion gas to the combustion apparatus. A recirculation blower 8 may be arranged within the recirculation line 14.

[0032] Additionally, flue gases downstream of the carbon capture device 7 can be provided to an air separation unit 11. This way, the amount of flue gases provided leaving the incineration plant through stack 12 is further reduced. The air separation unit 11 provides oxygen enriched gas through a further recirculation line 15 comprising blower 17 to the combustion gas line, so that the combustion gas provided to the combustion chamber 2 has a comparatively high oxygen content. If no ambient air is provided to the combustion chamber 2, the combustion gas may be composed primarily of the recirculated flue gases comprising mainly carbon dioxide, water vapour, oxygen from the air separation unit 11 or from another oxygen source.

[0033] By providing combustion gases with a comparatively high oxygen and carbon dioxide concentration, the combustion conditions within the combustion chamber 2 approach the combustion conditions of a so-called oxy-fuel combustion process occurs. Therefore, the combustion gases leaving the combustion chamber 2 have a comparatively high CO_2 concentration. As flue gases withdrawn from downstream of the dedusting unit 3 and the separator 4 are used as operating gas of the dedusting unit 3 and the separator 4 an as operating gas of the combustion apparatus, the dilution of the carbon dioxide concentration of the flue gases within the com-

bustion apparatus and the dedusting unit 3 and the separator 4 is avoided or reduced.

[0034] The operating gas may be used within the flue gas treatment units 3, 4, for example as sealing gas to seal the flue gases within the flue gas treatment unit against the surrounding, as transporting medium for transporting additives needed to operate the flue gas treatment unit, as fluidizing gas for operating a fluidizing gutter and/or as cleaning gas for cleaning a filter of the flue gas treatment unit 3, 4.

[0035] The operating gas may be used within the combustion apparatus, for example as cooling gas for auxiliary burners, as sealing and cooling gas in boiler cleaning systems (such as water spraying system, rapping device, soot blower) and as transporting medium for additive injection.

Reference Signs

[0036]

1	Substitute fuel
2	Combustion chamber
3	Dedusting unit
4	Separator for acid gases
5	Heat exchanger
6	Blower
7	Carbon capture device
8	Recirculation blower
9	Combustion gas preheater
10	Combustion gas blower
11	Air separation unit
12	Stack
13	Operating gas inlet
14	Recirculation line
15	Recirculation line
16	Grate
17	Blower
18	Boiler
19	Combustion gas inlet

Claims

1. Method for the combustion of fuels, comprising the following steps:

a) Combusting the fuel in a combustion apparatus (2, 18), wherein a combustion gas is provided to the combustion process,
b) Treating flue gases from the combustion process in one flue gas treatment unit or in multiple flue gas treatment units (3, 4) downstream of the combustion apparatus (2, 18),
c) Providing an operating gas to at least one operating gas inlet (13) of at least one flue gas treatment unit (3, 4) and/or to at least one operating gas inlet (13) of the combustion apparatus (2, 18),

characterized in that
the operating gas comprises at least 10 Vol-% carbon dioxide (CO_2).

2. Method according to claim 1, wherein treated flue gases from downstream of one of the flue gas treatment unit(s) (3, 4) is withdrawn and provided at least as part of the operating gas to the operating gas inlet (13) of the at least one flue gas treatment unit (3, 4) and/or to the operating gas inlet of the combustion apparatus (2, 18).

3. Method according to claim 1 or 2, wherein in step a) a combustion gas having a higher oxygen concentration than air is provided to a combustion chamber (2) of the combustion apparatus (2, 18).

4. Method according to one of the preceding claims, wherein treated flue gas is withdrawn from downstream of one of the flue gas treatment unit(s) (3, 4) and provided as part of the combustion gas to the combustion apparatus (2, 18).

5. Method according to one of the preceding claims, wherein the operating gas is used

- as sealing gas,
- as transporting medium for transporting additives,
- as fluidizing gas for operating a fluidizing gutter,
- as cleaning gas for cleaning a filter and/or
- as cooling gas.

6. Method according to one of the preceding claims, wherein carbon dioxide comprised in the flue gases is captured downstream of the one or multiple flue gas treatment unit(s) (3, 4).

7. Method according to claim 6, wherein flue gases from which carbon dioxide has been removed is provided to an air separation unit (11), which air separation unit (11) provides oxygen as part of the combustion gas to the combustion process.

8. Incineration plant having

- a combustion apparatus (2, 18), wherein the combustion apparatus (2, 18) comprises at least one combustion gas inlet (19) for a combustion gas,
- one flue gas treatment unit or multiple flue gas treatment units (3, 4) downstream of the combustion apparatus (2, 18),

wherein the combustion apparatus (2, 18) and/or at least one flue gas treatment unit (3, 4) comprises at least one operating gas inlet (13) for an operating gas,
characterized in that

at least one operating gas inlet (13) is connected to a source of carbon dioxide (CO_2).

9. Incineration plant according to claim 8, wherein a recirculation line (14) for withdrawing treated flue gases from downstream of one of the flue gas treatment unit(s) (3, 4) is connected to the operating gas inlet (13) as a source of carbon dioxide (CO_2).

10. Incineration plant according to claim 8 or 9, wherein an oxygen source (11) is connected to the combustion gas inlet (19), so that a combustion gas having a higher oxygen concentration than air is provided to the combustion apparatus (2).

11. Incineration plant according to claim 8 to 10, wherein a recirculation line for withdrawing treated flue gases from downstream of the one of the flue gas treatment unit(s) (3, 4) is connected to the combustion gas inlet of the combustion apparatus (2).

12. Incineration plant according to one of the preceding claims 8 to 11,
wherein at least one flue gas treatment unit (3, 4) is embodied as a dedusting unit (3) with an operating gas inlet or as a cleaning unit (4) for removing acid gases with an operating gas inlet.

13. Incineration plant according to one of the preceding claims 8 to 12,
wherein the combustion apparatus comprises at least

- at least one auxiliary burner with an operating gas inlet (13) for a cooling gas,
- a boiler cleaning system with an operating gas inlet (13) for a sealing gas and/or for a cooling gas or
- at least one additive injection system with an operating gas inlet (13) for a transporting medium.

14. Incineration plant according to one of the preceding claims 8 to 13, wherein a carbon capture device (7) is arranged downstream of the one or multiple flue gas treatment unit(s) (3, 4).

15. Incineration plant according to one of the preceding claims 8 to 14, wherein a combustion chamber (2) of the combustions apparatus comprises a grate (16), with which the fuel is transported through the combustion chamber (2).

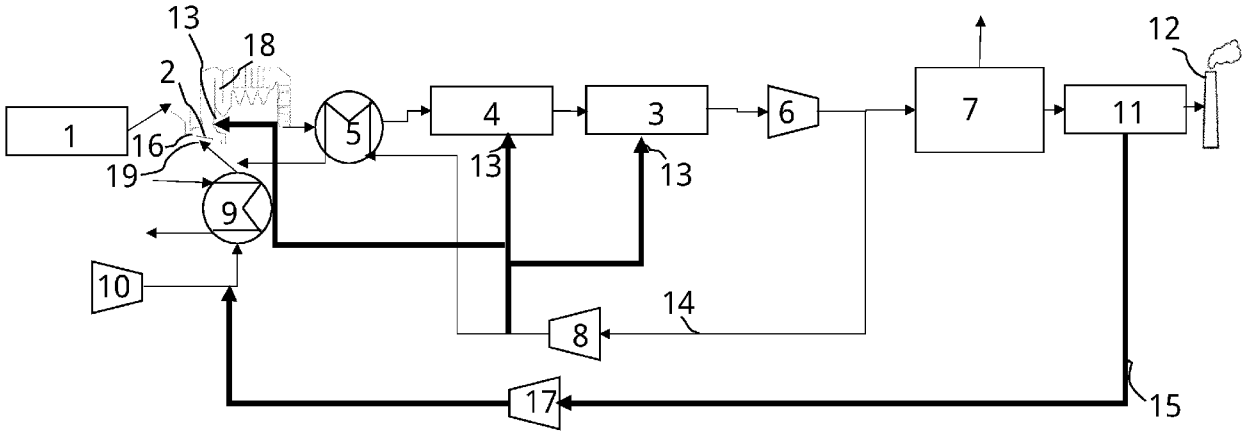

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 24 16 5228

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TECHNICAL FIELDS SEARCHED (IPC)

F23C
F23J
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	9 August 2024	Theis, Gilbert

CATEGORY OF CITED DOCUMENTS

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