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(54) **INCINERATION PLANT**

(57) The present invention relates to an incineration plant for solid material having
- a combustion chamber (1) in which the solid material is combusted and which is partly delimited by a front ceiling (7),
- a combustion grate (2) with which the solid material and combusted solid material can be conveyed through the combustion chamber (1),
- a primary air supply (3) below the top of the combustion grate (2),
- a first pass (4) arranged above the combustion chamber (1), the combustion chamber (1) and the first pass (4) forming a transition region (5) between the combustion chamber (1) and the first pass (4) such that a center flow arrangement is embodied.

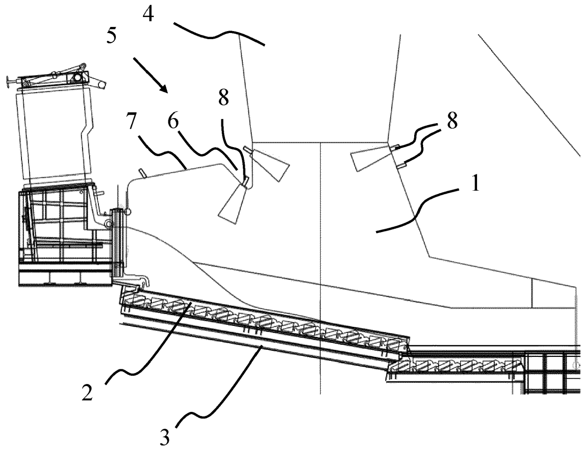

Fig. 1

EP 4 047 271 A1

Description

[0001] The present invention relates to an incineration plant for solid material (i.e. waste or biomass) having a combustion chamber in which the solid material is combusted and which is partly delimited by a front ceiling, a combustion grate with which the solid material and combusted solid material can be conveyed through the combustion chamber, a primary air supply below the top of the combustion grate, a first pass arranged above the combustion chamber, the combustion chamber and the first pass forming a transition region between the combustion chamber and the first pass such that a center flow arrangement is embodied. The incineration plant may also comprise a combustion material inlet through which solid material can be introduced, a feed shaft in which the solid material is introduced and which leads to the combustion chamber.

[0002] The combustion grate is usually arranged within a lower section of the combustion chamber. The solid material (i.e. waste) and combusted solid material can be conveyed by the combustion grate through the combustion chamber from an end of the combustion material feed shaft to a slag container. Primary air is supplied from below the combustion grate to the solid material arranged on the combustion grate, so that the solid material arranged on the combustion grate is combusted with the primary air. The main process steps on the grate (in the direction of travel of the solid waste) are: drying of the waste, devolatilization, combustion, afterburning of the solid residues (mainly ash and slag). The solid material and combusted solid material conveyed by the combustion grate is also referred to as solid material bed.

[0003] The combustion grate is preferably embodied as reciprocating grate, but it is also possible that the combustion grate is embodied in a different way, for example as vibrating grate, travelling grate or roller grate.

[0004] Additionally, nozzles may be arranged above the combustion grate within the combustion chamber and/or within the first pass, with which nozzle(s) secondary air, tertiary air for afterburning or an oxygen poor carrier gas can be provided to the combustion gases.

[0005] The first pass (in German: erster Zug) is to be understood that part of the incineration plant above the combustion grate, in which the combustion gases from the combustion chamber advance upwards, wherein secondary air, tertiary air for afterburning or other gases may be added to the combustion gases in the first pass.

[0006] Principally, three different designs of the arrangement of the first pass in relation to the combustion chamber can be distinguished in incineration plants with grate firing. The nomenclature derives from the flow direction of the flue gases/combustion gases in relation to the direction of travel of the solid material bed, namely: parallel flow (also called unidirectional current flow or co-current flow, in German: Gleichstromfeuerung), counter flow (also called countercurrent flow, in German: Gegenstromfeuerung) and center flow (also called medium current flow, in German: Mittelstromfeuerung).

[0007] In a parallel flow arrangement (which is not covered by the present invention), primary combustion gases and waste are guided in a co-current flow through the combustion chamber. Accordingly, the transition region between the combustion chamber and the first pass is located at the end of the combustion grate. Only a comparatively low amount of energy is exchanged between the combustion gases and the waste on the grate. The advantage of parallel flow concepts is that the flue-gas has the longest residence time in the ignition area and that it must pass through the maximum temperature.

[0008] In case of a counter flow arrangement (which is also not covered by the present invention), primary combustion gases and waste are guided in a countercurrent flow arrangement through the combustion chamber and the transition region between the combustion chamber and the first pass is located at the front of the combustion grate. In this case, the hot flue-gases facilitate drying and ignition of the waste.

[0009] In case of a center-flow arrangement the transition region between the combustion chamber and the first pass is located above the middle of the combustion grate. With such an arrangement the composition of solid waste may vary considerably and thus a compromise for a wide feed value spectrum is given. Such a center flow arrangement is also characterized in that combustion gases from the first section of the solid material bed need to flow along the direction of travel of the combustion grate in order to flow into the first pass and that combustion gases from the last section of the solid material bed need to flow against the direction of travel of the solid material bed in order to flow into the first pass.

[0010] The present invention relates to these center-flow arrangements only. Accordingly, the present invention relates to incineration plants, in which the transition region between the combustion chamber and the first pass is located above the middle of the combustion grate.

[0011] In order that flue gases emerging from the solid material bed on the first section of the combustion grate (in which drying and eventually devolatilization occurs) the combustion chamber of a center-flow arrangement comprises a front (upper) ceiling, which is in particular horizontally oriented or inclined slightly upwards towards the first pass. This front ceiling is delimiting the combustion chamber at the beginning/front of the combustion chamber in the direction of travel of the solid waste. Accordingly, the front ceiling is arranged above a first section of the combustion grate in case of a center flow furnace.

[0012] In order that flue gases emerging from the combusted solid waste on the last section of the combustion grate (in which afterburning and cooling occurs) the combustion chamber of a center-flow arrangement usually comprises a rear (upper) ceiling, which is in particular inclined upwards towards the first pass. This rear ceiling is delimiting the combustion chamber at the end of the combustion chamber in the direction of travel of the solid waste. Accordingly, the rear ceiling is arranged above a last section of the combustion grate in case of a center flow furnace.

[0013] In a preferred embodiment the transition region may embody a constriction, meaning that the cross section of the combustion chamber in a vertical direction decreases towards the constriction and that the cross section of the first pass increases in a vertical direction above the constriction.

[0014] At least one empty pass may be arranged downstream of the first pass extending vertically or horizontally, wherein the flue gases flow from the first pass through the at least one empty pass to a heat recovery steam generator.

[0015] A heat recovery steam generator downstream of the empty pass may be arranged (in sections) vertically and/or horizontally, wherein also an oblique orientation is possible.

[0016] The walls of the combustion chamber, the first pass, the empty pass(es) and the heat generator 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. The walls of the combustion chamber are usually lined with refractory bricks, while the wall of the first pass is usually directly formed by tubes, wherein adjacent tubes are interconnected by metallic sheets (also called fins).

[0017] A flue gas purification device downstream of the heat recovery steam generator may comprise elements for dedusting, scrubbing and/or desulfurization (such as SCR or SNCR) of the flue gas. A chimney may be arranged downstream of the flue gas purification device.

[0018] An incineration plant with the above described features is known from WO2020187637A1. In such a center flow furnaces depositions on the walls of the first pass have to be elaborately removed.

[0019] Accordingly, it is an object of the present invention to overcome the drawbacks of the prior art and in particular to provide an incineration plant, which needs to be maintained less regularly.

[0020] This object is achieved with an incineration plant according to the independent claim. Preferred embodiments of the incineration plant are disclosed in the subclaims and in the above and below description, wherein single features of the preferred embodiments can be combined with each other in a technical meaningful manner.

[0021] The object is in particular achieved with an incineration plant as described above, wherein a protrusion is embodied in the transition region, which extends downwards below the front ceiling.

[0022] It has been found that by such a protrusion the depositions on the wall of the first pass are reduced. It is believed that by the protrusion a vortex like flow of the flue gases/combustion gases from the drying/devolatilization area of the solid material bed of the combustion grate is produced, so that these flue gases (which might comprise i.e. aerosols and other components, which are to be removed elaborately from the wall of the first pass after its deposition) do not directly flow into the first pass, but are deflected downwards towards the combustion grate. This way, the effort for removing depositions from the walls of the first pass can be reduced.

[0023] With other words, by having at least one protrusion in the transition region the combustion chamber is (virtually) divided in a vortex chamber at the front of the combustion chamber (viewed in the direction of travel of the solid waste) and a main combustion chamber, in which the combustion and afterburning occurs. Accordingly, the at least one protrusion is arranged in such a way in the transition region that flue gases from the first part of the combustion grate are forced in a downward oriented flow and preferable in a vortex flow.

[0024] The transition region is partly embodied by the combustion chamber and partly embodied by the first pass. Accordingly, the projection may be attached to or embodied by a wall section of the primary pass. But, preferably, the protrusion might be arranged at the front ceiling or may be part of the front ceiling. In any case the protrusion needs to extend downwards below the neighboring section of the front ceiling so that combustion gases/flue gases from the first section of the solid material bed are deflected downwards or even into a vortex like stream.

[0025] Principally, it would be sufficient, that there is one protrusion or that there are multiple protrusions arranged beside each other along the width of the primary combustion chamber. Preferably, there is exactly one protrusion, which extends over the whole width of the primary combustion chamber. This way a single (in cross sectional view) nose shaped deflection wall is formed, so that all flue gases from the first section of the combustion grate are deflected downwards.

[0026] In a preferred embodiment, the protrusion has its greatest cross section at its base near the front ceiling, while the cross section of the protrusion decreases to a tip of the protrusion.

[0027] As long as the protrusion extends downwards from the adjacent section of the front wall, the protrusion may also extend in the direction of travel of the combustion grate, so that the tip of the protrusion is arranged below a constriction of the transition region. Alternatively, the protrusion may also extend against the direction of travel of the combustion grate.

[0028] In order to supply secondary air or other process gases to the flue gases of the first section of the solid material bed, at least one nozzle may be arranged within the protrusion. If multiple protrusions are embodied, one nozzle may be arranged within each protrusion. Preferably, multiple nozzles are provided, which are arranged besides each other in the exactly one protrusion extending over the whole width of the primary combustion chamber. By injecting secondary air or other process gases a free-jet of the secondary air or of process gas is produced, which free-jet enhances the deflection of the flue gases induced by the protrusion. Depending on the injection parameters (for example cross section of the nozzle or pressure of the gas) of the free-jet the penetration depth of the free-jet may be set. The resulting free-jet decreases in velocity while its mass enhances by sucking in the surrounding flue gases.

[0029] The at least one nozzle may be oriented in such a way, that the resulting free-jet is oriented backwards towards a combustion chamber inlet (which inlet might be embodied by the outlet of the feed shaft to the combustion chamber). It is also possible that the nozzle is oriented in such a way that the resulting free-jet is oriented downwards. Nevertheless, the nozzle may be oriented in any direction in between, so that the free-jet has an angle between 0° and 90° to a vertical plane. Most preferably, the nozzle is oriented 40° to 50° in relation to the vertical plane.

[0030] For deflecting the flue gases downwardly efficiently, it has been found that the projection protrudes over the neighboring/adjacent parts of the front ceiling by at least 0,5 m, preferably by at least 1 m, which might depend on the size of the combustion chamber. In a relative relation the projection has such an extension downwards that the height of the primary combustion chamber (measured from the top of the combustion grate straightly upwards until the ceiling) along the direction of travel of the combustion grate is reduced by the protrusion by at least 10 %, preferable by at least 20 %. Accordingly, the height of the combustion chamber at the maximum extension of the protrusion is at least 10% less than the height of the combustion chamber in front of the protrusion.

[0031] The invention and the technical background will now be described with regard to the figure.

[0032] The figure depicts schematically a combustion chamber 1 and a first pass 4 of an incineration plant for waste. At the bottom of the combustion chamber 1 a combustion grate 2 is arranged, with which the waste can be conveyed from a combustion chamber inlet (on the left side of the figure) to a (not shown) slag container on the right lower side of the combustion chamber 1. Primary air is supplied from below the combustion grate 2 by a primary air supply 3. Secondary air can be supplied into the combustion chamber 1 by secondary nozzles 8. The front section of the combustion chamber 1 is delimited by a front ceiling 8.

[0033] The combustion chamber 1 and the first pass 4 define a transition region 5. The first pass 4 is arranged above the middle of the combustion grate 3, thereby embodying a center flow type incineration plant.

[0034] One protrusion 6 extending over the whole width of the combustion chamber 1 is formed in the transition region 5. The protrusion 6 extends downwards below the front ceiling 7, so that combustion gases from the solid material bed in the first section of the combustion chamber 1 are deflected downwards and eventually into a vortex flow. This way aerosols and other components of the flue gas from the first section of the solid material bed on top of the combustion grate 3 are forced downwardly into the main combustion area of the combustion chamber 1. This way depositions on the walls of the first pass 4 are reduced.

Claims

1. Incineration plant for solid material having

    - a combustion chamber (1) in which the solid material is combusted and which is partly delimited by a front ceiling (7),
    - a combustion grate (2) with which the solid material and combusted solid material can be conveyed through the combustion chamber (1),
    - a primary air supply (3) below the top of the combustion grate (2),
    - a first pass (4) arranged above the combustion chamber (1), the combustion chamber (1) and the first pass (4) forming a transition region (5) between the combustion chamber (1) and the first pass (4) such that a center flow arrangement is embodied,

    characterized in that
    a protrusion (6) is embodied in the transition region (5) which extends downwards below the front ceiling (7).

2. Incineration plant according to claim 1, wherein one protrusion (6) extends over the whole width of the combustion chamber (1).

3. Incineration plant according to claim 1 or 2, wherein at least one nozzle (8) is arranged within the protrusion (6).

4. Incineration plant according to claim 3, wherein the at least one nozzle (8) is directed backwards towards a combustion chamber inlet.

5. Incineration plant according to claim 3 or 4, wherein the at least one nozzle (8) is directed downwards.

6. Incineration plant according to one of the preceding claims, wherein the protrusion (6) protrudes at least 0,5 m, preferably at least 1 m downwards from the adjacent part of the front ceiling (7).

7. Incineration plant according to one of the preceding claims, wherein the protrusion (6) has such an extension that the height of the combustion chamber (1) along the direction of travel of the combustion grate (2) is reduced by the protrusion by at least 10%.

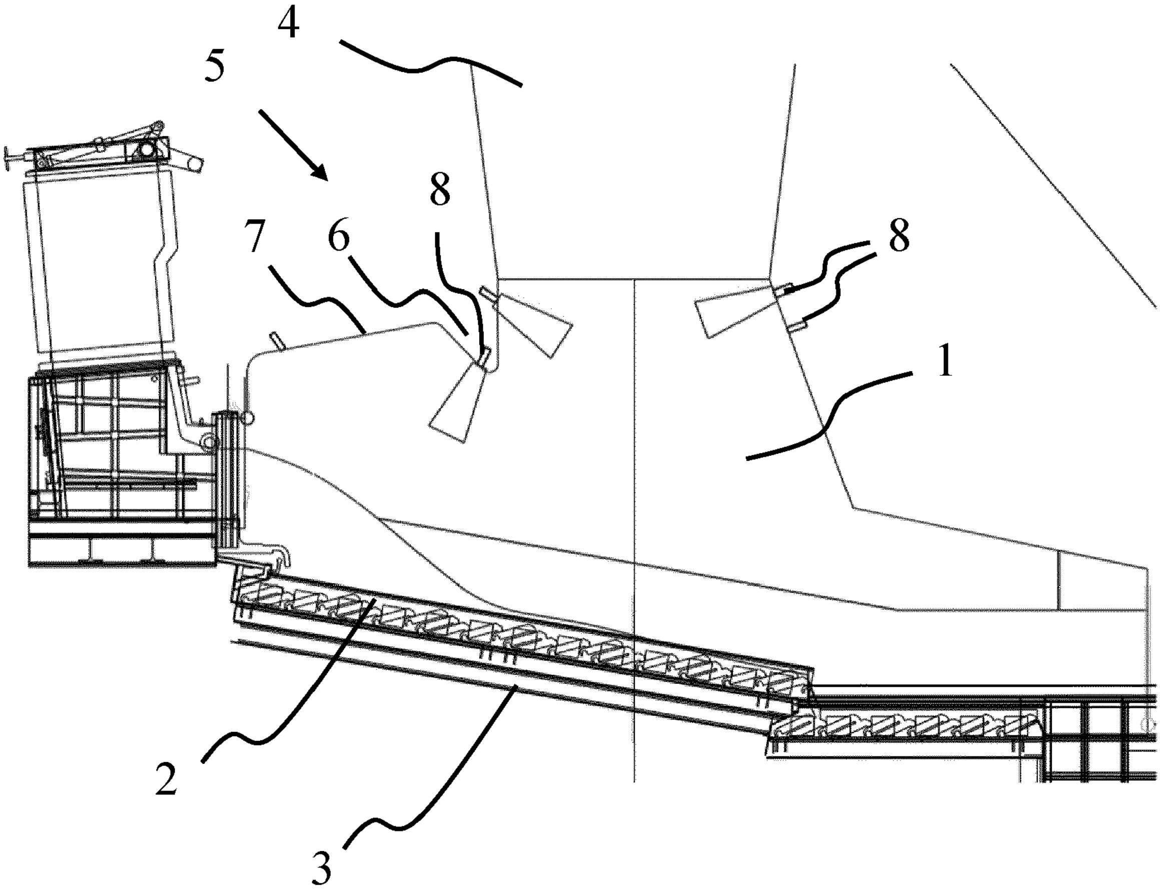

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 21 15 8466

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DE 196 48 639 A1 (STEINMUELLER GMBH L & C [DE]) 23 April 1998 (1998-04-23) * column 3, line 7 - column 4, line 18; figures 1-3 * -----	1	INV. F23G5/44
A	EP 0 741 267 A1 (BABCOCK ANLAGEN GMBH [DE]) 6 November 1996 (1996-11-06) * column 2, line 40 - column 4, line 31; figures 1,4 * -----	1	
A	JP 2016 090089 A (KAWASAKI HEAVY IND LTD) 23 May 2016 (2016-05-23) * paragraph [0017] - paragraph [0038]; figures 1,2 * -----	1	
A	JP 2002 022125 A (KOBE STEEL LTD) 23 January 2002 (2002-01-23) * the whole document * -----	1	
A	CN 211 204 051 U (EVERBRIGHT ENVIRONMENTAL PROTECTION RES INST NANJING CO LTD ET AL.) 7 August 2020 (2020-08-07) * the whole document * -----	1	

TECHNICAL FIELDS SEARCHED (IPC)
F23G

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	9 July 2021	Theis, Gilbert

CATEGORY OF CITED DOCUMENTS

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09-07-2021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19648639 A1	23-04-1998	NONE	
EP 0741267 A1	06-11-1996	AT 203809 T	15-08-2001
		EP 0741267 A1	06-11-1996
		ES 2161798 T3	16-12-2001
		JP 2000513796 A	17-10-2000
		KR 19990008293 A	25-01-1999
		PL 323139 A1	16-03-1998
		TW 319816 B	11-11-1997
		US 6138587 A	31-10-2000
		WO 9635081 A1	07-11-1996
JP 2016090089 A	23-05-2016	JP 6397308 B2	26-09-2018
		JP 2016090089 A	23-05-2016
JP 2002022125 A	23-01-2002	JP 3887149 B2	28-02-2007
		JP 2002022125 A	23-01-2002
CN 211204051 U	07-08-2020	NONE	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- WO 2020187637 A1 **[0018]**