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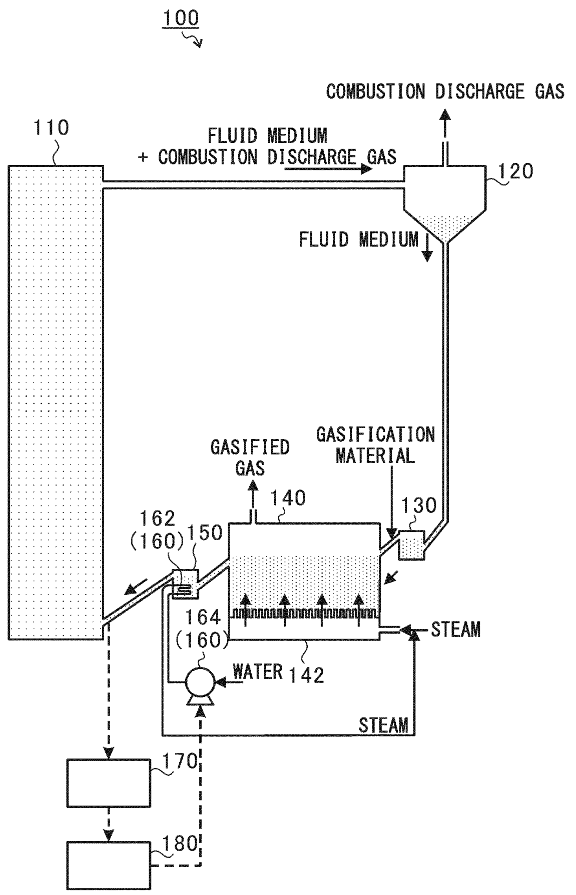
(54) GASIFIED-GAS GENERATION SYSTEM

(57) A gasified-gas generation system (100) includes: a combustor (110) that heats a fluid medium; a gasifier (140) into which the fluid medium heated by the combustor (110) is introduced and which gasifies a gasification material with heat of the fluid medium so as to generate a gasified gas; and a cooling mechanism (160) that cools the fluid medium that flows between the gasifier (140) and the combustor (110). The fluid medium circulates between the combustor (110) and the gasifier (140). The fluid medium and a residue of the gasification material are introduced from the gasifier (140) into the combustor (110), and the combustor (110) burns the residue to heat the fluid medium.

FIG. 1



EP 2 977 432 A1

Description

[Technical Field]

[0001] The present invention relates to a gasified-gas generation system that gasifies a gasification material to generate a gasified gas.

[0002] Priority is claimed on Japanese Patent Application No. 2013-57509, filed on March 21, 2013, the contents of which are incorporated herein by reference.

[Background Art]

[0003] In recent years, technologies for gasifying a gasification material such as coal, biomass, or tire chips in place of petroleum to generate a gasified gas have been developed. The gasified gas generated in this way is used in power generation systems, production of hydrogen, production of synthetic fuel (synthetic petroleum), or production of chemical products such as chemical fertilizers (urea). Among gasification materials used as feedstock for gasified gases, coal in particular has a reserves-to-production ratio of about 150 years, which is at least three times that of the petroleum, and is also being anticipated as a natural resource that can be stably supplied over a long period of time because its deposits are distributed more evenly than those of petroleum.

[0004] As technology for gasifying a gasification material such as coal, technology for gasifying a gasification material in a gasifier in which a fluid medium forms a fluidized bed from steam of about 800°C has been developed (for instance, Patent Document 1).

[0005] In the technology of Patent Document 1, an apparatus equipped with a combustor and a gasifier is used, the fluid medium heated by the combustor is introduced into the gasifier, the gasification material is gasified in the gasifier, and then the fluid medium is introduced from the gasifier into the combustor. In this way, in the technology of Patent Document 1, the fluid medium circulates between the combustor and the gasifier. Also, in the technology of Patent Document 1, the residue (char) of the gasification material after the gasification is introduced into the combustor together with the fluid medium, and the residue is burned in the combustor and heats the fluid medium.

[0006] In addition, Patent Documents 2 to 5 also describe gasifiers using fluid media.

[Citation List]

[Patent Document]

[0007]

[Patent Document 1]
Japanese Patent No. 3933105
[Patent Document 2]
Japanese Unexamined Patent Application, First Publication No. 2005-41959
[Patent Document 3]
Japanese Unexamined Patent Application, First Publication No. H07-35322
[Patent Document 4]
Japanese Unexamined Patent Application, First Publication No. 2003-176486
[Patent Document 5]
Japanese Unexamined Patent Application, First Publication No. 2013-46893

[Summary of Invention]

[Technical Problem]

[0008] In the gasified-gas generation system through which the fluid medium circulates described in Patent Document 1 described above, a fuel of the combustor is the residue of the gasification material. Accordingly, the amount of heating of the fluid medium in the combustor becomes a difference between the amount of heat generated by burning the residue and the amount of heat radiated from the combustor.

[0009] The amount of residue introduced into the combustor depends on the amount of generated gasified gas required for the gasifier, and the amount of heat radiated from the combustor depends on the size (volume) of the combustor. To be specific, the surface area per unit volume (specific surface area) of the combustor is larger when the combustor is smaller, i.e., when the size of the gasified-gas generation system is smaller. Thus, the amount of heat radiated from the combustor increases. Further, the specific surface area is smaller when the combustor is larger. Thus, the amount of heat radiated from the combustor decreases.

[0010] Here, if the size of the gasified-gas generation system is enlarged in order to increase the generated amount of the gasified gas, the amount of the residue introduced into the combustor increases, and the amount of heat radiated from the combustor decreases. Thus, the amount of heating of the fluid medium in the combustor increases excessively (the combustor overheats). As a result, the fluid medium may be dissolved and lose its function as a fluid medium. In addition, if the temperature of the fluid medium rises excessively, the combustor or pipes connecting the combustor and the gasifier, for example, needs to have increased strength at high temperatures, which results in an increased cost.

[0011] The present invention has been made in consideration of this problem, and an object of the present invention is to provide a gasified-gas generation system capable of preventing a combustor from overheating without reducing the amount of generated gasified gas.

[Solution to Problem]

[0012] A gasified-gas generation system according to a first aspect of the present invention includes: a combustor configured to heat a fluid medium; a gasifier into which the fluid medium heated by the combustor is introduced and which gasifies a gasification material with heat of the fluid medium so as to generate a gasified gas; and a cooling mechanism configured to cool the fluid medium flowing between the gasifier and the combustor. The fluid medium circulates between the combustor and the gasifier. The fluid medium and a residue of the gasification material are introduced from the gasifier into the combustor, and the combustor burns the residue to heat the fluid medium.

[0013] Also, in the gasified-gas generation system according to a second aspect of the present invention, in the first aspect, the cooling mechanism is provided at a downstream side of the gasifier, and cools the fluid medium which flows an upstream side of the combustor.

[0014] Also, the gasified-gas generation system according to a third aspect of the present invention includes: in the first or second aspect, a temperature measuring unit configured to measure the temperature of the fluid medium at an inlet of the combustor; and a control unit configured to control the cooling mechanism based on the temperature measured by the temperature measuring unit so as to cool the fluid medium to be within a preset temperature range.

[0015] Also, the gasified-gas generation system according to a fourth aspect of the present invention includes: in the first to third aspects, a loop seal provided between the gasifier and the combustor and configured to prevent any one or both of an outflow of the gasified gas generated by the gasifier to the combustor and an inflow of a gas from the combustor to the gasifier. The cooling mechanism cools the fluid medium in the loop seal.

[0016] In addition, in the gasified-gas generation system according to a fifth aspect of the present invention, in the first to fourth aspects, the in the first to fourth aspects, the cooling mechanism exchanges heat between water and the fluid medium to cool the fluid medium and generate steam. Further, the cooling mechanism includes an introduction unit that introduces the steam generated by the cooling mechanism into the gasifier, and the gasification material in the gasifier is gasified by the steam.

[Advantageous Effects of Invention]

[0017] According to the present invention, the gasified-gas generation system can prevent the combustor from overheating without reducing the amount of generated gasified gas.

[Brief Description of Drawings]

[0018]

FIG. 1 is a drawing for explaining a specific constitution of a gasified-gas generation system.

FIG. 2 is a drawing for explaining a specific constitution of a cooling mechanism.

[Description of Embodiments]

[0019] Hereinafter, a preferred embodiment of the present invention will be described in detail with reference to the attached drawings. Dimensions, materials, other specific numerical values, and so on indicated in these embodiments are merely examples for facilitating comprehension of the invention, and unless indicated otherwise, the present invention is not limited thereto. Note that in the specification and drawings, elements having substantially the same functions and constitutions will be given the same reference numerals, and a duplicate description thereof will be omitted. Further, elements not directly related to the present invention are not shown in the drawings.

(Gasified-gas generation system 100)

[0020] FIG. 1 is a drawing for explaining a specific constitution of a gasified-gas generation system 100. As shown in FIG. 1, the gasified-gas generation system 100 includes a combustor 110, a medium separator (cyclone) 120, a loop seal 130, a gasifier 140, a loop seal 150, a cooling mechanism 160, a temperature measuring unit 170, and a control unit 180. Note that, in FIG. 1, streams of materials such as a fluid medium, a gasification material, a gasified gas, water, steam, and a combustion discharge gas are indicated by solid line arrows, and streams of signals are indicated by broken line arrows.

[0021] In the present embodiment, the gasified-gas generation system 100 is a circulating fluidized bed type gasification system, and generally circulates a fluid medium composed of sands such as silica sands having a particle diameter of about 300 μm as a heat carrier. To be specific, first, the fluid medium is heated in the combustor 110 at about 900°C to 1000°C, and is introduced into the medium separator 120 together with the combustion discharge gas. In the medium separator 120, the combustion discharge gas is separated from the high-temperature fluid medium, and heat is recovered from the separated combustion discharge gas by a heat exchanger (e.g., a boiler) that is not shown.

[0022] On the other hand, the high-temperature fluid medium separated by the medium separator 120 is introduced into the gasifier 140 via the loop seal 130. Although the details will be described below, the loop seal 130 has a fluidized bed formed therein, and serves to prevent an inflow of the combustion discharge gas from the medium separator 120 to the gasifier 140 and an outflow of the gasified gas from the gasifier 140 to the medium separator 120.

[0023] The fluid medium introduced from the medium separator 120 into the gasifier 140 via the loop seal 130 flows with a gasifying agent (here, steam) introduced from a steam distribution unit 142, and returns to the combustor 110 via the loop seal 150.

[0024] In this way, in the gasified-gas generation system 100 relating to the present embodiment, the fluid medium moves to the combustor 110, the medium separator 120, the loop seal 130, the gasifier 140, and the loop seal 150 in this order, and is introduced into the combustor 110 again. Thereby, the fluid medium circulates.

[0025] In addition, the steam distribution unit 142 is provided at a lower side of the gasifier 140, and steam supplied from a steam supply source (not shown) is introduced from the bottom of the gasifier 140 into the gasifier 140 via the steam distribution unit 142. In this way, the steam is introduced into the high-temperature fluid medium introduced from the medium separator 120, and thereby a fluidized bed (bubble fluidized bed) is formed in the gasifier 140.

[0026] A gasification material (solid material) such as coal, biomass, or tire chips is introduced into the gasifier 140. The introduced gasification material is gasified by heat of about 800°C to 900°C of the fluid medium. Thereby, a gasified gas (synthetic gas) is generated.

[0027] In the gasified-gas generation system 100 in which this fluid medium circulates between the combustor 110 and the gasifier 140, a residue that remains after the gasification material is gasified in the gasifier 140 is introduced into the combustor 110. Accordingly, the residue introduced from the gasifier 140 into the combustor 110 becomes a fuel (heat source) in the combustor 110. The fluid medium is heated in the combustor 110 by heat generated by burning the residue. That is, the amount of heating of the fluid medium in the combustor 110 becomes the difference between the amount of heat generated by burning the residue and the amount of heat radiated from the combustor 110.

[0028] Here, the amount of residue introduced into the combustor 110 depends on the amount of generated gasified gas required for the gasifier 140, and the amount of heat radiated from the combustor 110 depends on the size (volume) of the combustor 110. For example, in a relatively small gasified-gas generation system 100 in which the throughput of the gasification material in the gasifier 140 is about 5 tons/day, the combustor 110 has a large specific surface area and radiates a large amount of heat. Thus, it is not always possible to heat the fluid medium to the temperature (800°C to 900°C), which is required for the gasifier 140, using only the residue. In that case, an additional fuel (auxiliary fuel) is introduced into the combustor 110 in addition to the residue.

[0029] In addition, for example, in a gasified-gas generation system 100 in which the throughput of the gasification material in the gasifier 140 is about 50 tons/day, the fluid medium can be heated to the temperature required for the gasifier 140, using only the residue. Thus, it is not necessary to introduce the auxiliary fuel into the combustor 110.

[0030] On the other hand, for example, in a relatively large gasified-gas generation system 100 in which the throughput of the gasification material in the gasifier 140 is about 500 to 2000 tons/day, the combustor 110 has a small specific surface area and radiates a small amount of heat. Thus, even if only the residue is burned, the fluid medium sometimes overheats to a temperature higher than the temperature required for the gasifier 140.

[0031] If the fluid medium overheats, the fluid medium may be dissolved. Also, for instance, the combustor 110 or the loop seal 150 or pipes connecting the combustor 110 and the gasifier 140 needs to be strengthened against high temperatures, which increases the cost of the gasified-gas generation system 100. In this case, to inhibit the combustor 110 from overheating, reducing the amount of the residue introduced from the gasifier 140 into the combustor 110, that is, reducing the amount of the gasification material introduced into the gasifier 140, may also be considered, but the required amount of generated gasified gas may not be secured.

[0032] Therefore, in the gasified-gas generation system 100 relating to the present embodiment, the overheating of the fluid medium is prevented by the cooling mechanism 160. The cooling mechanism 160 includes a circulation pipe 162 and a pump 164, and cools the fluid medium flowing between the gasifier 140 and the combustor 110. In the present embodiment, the cooling mechanism 160 cools the fluid medium flowing through the loop seal 150.

[0033] FIG. 2 is a drawing for explaining a specific constitution of the cooling mechanism 160 relating to the present embodiment. As shown in FIG. 2, the loop seal 150 of the present embodiment is provided with a steam distribution unit 152 at a lower portion thereof, and steam supplied from a steam supply source (not shown) is introduced from the bottom of a main body 154 provided at the lower portion of the loop seal 150 into the main body 154 via the steam distribution unit 152.

[0034] In this way, the steam is introduced into the fluid medium and the residue introduced from the gasifier 140 via an inlet 150a of the loop seal 150, and thereby a fluidized bed (bubble fluidized bed) is formed in the loop seal 150 (or the main body 154). Thus, when a height of the fluidized bed in a vertical direction increases due to additional introduction of a fluid medium and the residue from the gasifier 140, the fluid medium and the residue overflow from an outlet 150b of the loop seal 150 and are introduced into the combustor 110.

[0035] Due to the constitution having the loop seal 150, an outflow of the gasified gas generated by the gasifier 140 to the combustor 110 and an inflow of a gas from the combustor 110 to the gasifier 140 can be prevented. The loop seal 130 has substantially the same constitution as the loop seal 150, and so a duplicate description thereof will be omitted.

[0036] The circulation pipe 162 constituting the cooling mechanism 160 has one end connected to the pump (introduction unit) 164 and the other end connected to the steam distribution unit 142 (see FIG. 1). Also, a part 162a of the circulation pipe 162 is disposed inside the main body 154 of the loop seal 150.

[0037] The pump 164 introduces water into the circulation pipe 162 in response to a control command of the control unit 180 to be described below. When the water is introduced into the circulation pipe 162 by the pump 164, the water exchanges heat with the fluid medium and the residue when flowing through the loop seal 150, and the fluid medium and the residue are cooled, whereas the water is heated into steam.

[0038] Due to the constitution having the cooling mechanism 160, the fluid medium can be cooled (release heat) without changing the amount of the residue, that is, without reducing the amount of generated gasified gas (introduced amount of the gasification material).

[0039] Meanwhile, since a gasification reaction is an endothermic reaction, even if the overheated fluid medium is introduced into the gasifier 140, the fluid medium is cooled in the gasifier 140. Accordingly, it does not particularly matter if the overheated fluid medium is introduced into the gasifier 140. However, since a combustion reaction is an exothermic reaction, if the overheated fluid medium is introduced into the combustor 110, the fluid medium further overheats in the combustor 110. Accordingly, if the overheated fluid medium is introduced into the combustor 110, the fluid medium may be dissolved in the combustor 110.

[0040] Therefore, the cooling mechanism 160 in the present embodiment cools the fluid medium flowing between the gasifier 140 and the combustor 110 (a downstream side of the gasifier 140 and an upstream side of the combustor 110). Thereby, the fluid medium introduced into the combustor 110 can be cooled, and a situation in which the combustor 110 overheats and the fluid medium is dissolved can be avoided.

[0041] In addition, since a fluidized bed needs to be formed in the loop seal 150, a volume is secured to some extent. As a result, a relatively great volume can be employed for installation of the circulation pipe 162. Accordingly, as the cooling mechanism 160 cools the fluid medium in the loop seal 150, the fluid medium can be efficiently cooled.

[0042] Also, in the present embodiment, the steam generated at the part 162a of the circulation pipe 162 disposed in the loop seal 150 is introduced into the gasifier 140 via the steam distribution unit 142. That is, the steam generated at the part 162a of the circulation pipe 162 is introduced into the gasifier 140 by driving the pump 164.

[0043] Thereby, energy for generating the steam required to gasify the gasification material can be reduced.

[0044] The temperature measuring unit 170 is made up of, for instance, a thermocouple, and measures the temperature of fluid medium at an inlet of the combustor 110.

[0045] The control unit 180 is composed of a semiconductor integrated circuit including a central processing unit (CPU), reads a program or a parameter for operating the CPU out of a read-only memory (ROM), cooperates with a random access memory (RAM) or another electronic circuit as a work area, and manages or controls the entire gasified-gas generation system 100. In the present embodiment, the control unit 180 controls the amount of driving of the pump 164 (cooling mechanism 160) so as to cool the fluid medium to a preset temperature range based on the temperature of the fluid medium in which the temperature measuring unit 170 measures.

[0046] Due to the constitution having the temperature measuring unit 170 and the control unit 180, the temperature of the fluid medium introduced into the combustor 110 can be maintained within the preset temperature range. Accordingly, the temperature of the fluid medium after being heated in the combustor 110 is set to a temperature range that is a temperature at which the fluid medium is not dissolved and that becomes a temperature required in the gasifier 140. Thereby, the temperature of the fluid medium in the gasifier 140 can be maintained at a temperature suitable for the gasification while the fluid medium is prevented from overheating. In addition, the amount of the residue introduced into the combustor 110 is derived based on the amount of gasification material introduced (required amount of the gasified gas), and then, the amount of heat generated by burning the introduced residue is derived. As a result, the amount of heating of the fluid medium in the combustor 110 can be derived based on the amount of heat generated and the amount of heat radiated by the combustor 110.

[0047] As described above, according to the gasified-gas generation system 100 relating to the present embodiment, the overheating of the combustor 110 can be prevented without reducing the amount of gasified gas generated.

[0048] While a preferred embodiment of the present invention has been described with reference to the drawings, it goes without saying that the present invention is not limited to this embodiment. It will be apparent to those skilled in the art that various modifications or alterations can be contrived and implemented within the scope described in the specification, and it will be understood that these modifications and alterations also fall within the technical scope of the present invention.

[0049] For example, in the aforementioned embodiment, the cooling mechanism 160 is provided at the downstream side of the gasifier 140 and cools the fluid medium flowing in the loop seal 150 provided at the upstream side of the combustor 110. However, as long as the fluid medium flowing between the gasifier 140 and the combustor 110 is cooled, there is no limitation on the cooling position of the fluid medium. For example, the fluid medium flowing through the pipe connecting the gasifier 140 and the loop seal 150 or the pipe connecting the loop seal 150 and the combustor 110 may be cooled. Also, a heat exchanger may be provided between the gasifier 140 and the combustor 110.

[0050] In addition, in the aforementioned embodiment, the constitution in which the cooling mechanism 160 cools the fluid medium flowing between the gasifier 140 and the combustor 110 has been described by way of example. However, in addition to the fluid medium flowing between the gasifier 140 and the combustor 110, the fluid medium flowing between the medium separator 120 and the gasifier 140 (provided at a downstream side of the medium separator 120 and flowing through an upstream side of the gasifier 140, for instance, through the loop seal 130) may be cooled. Thereby, the temperature of the fluid medium in the gasifier 140 can be maintained within a desired temperature range.

[0051] Furthermore, in the aforementioned embodiment, the cooling mechanism 160 configured to include the circulation pipe 162 and the pump 164 has been described. However, the cooling mechanism 160 need only be able to cool the fluid medium and generate steam by exchanging heat between the water and the fluid medium. For example, the cooling mechanism 160 may be configured of a natural circulation boiler (drum boiler) for which the pump 164 is not required.

[Industrial Applicability]

[0052] The present invention can be used in the gasified-gas generation system that gasifies the gasification material to generate the gasified gas.

[Reference Signs List]

[0053]

100: gasified-gas generation system
110: combustor
140: gasifier
150: loop seal
160: cooling mechanism
162: circulation pipe
164: pump (introduction unit)
170: temperature measuring unit
180: control unit

Claims

1. A gasified-gas generation system comprising:

a combustor configured to heat a fluid medium;
a gasifier into which the fluid medium heated by the combustor is introduced and which gasifies a gasification material with heat of the fluid medium so as to generate a gasified gas; and
a cooling mechanism configured to cool the fluid medium flowing between the gasifier and the combustor,
wherein the fluid medium circulates between the combustor and the gasifier, and
the fluid medium and a residue of the gasification material are introduced from the gasifier into the combustor, and the combustor burns the residue to heat the fluid medium.

2. The gasified-gas generation system according to claim 1, wherein the cooling mechanism is provided at a downstream side of the gasifier, and cools the fluid medium which flows an upstream side of the combustor.

3. The gasified-gas generation system according to claim 1, comprising:

a temperature measuring unit configured to measure a temperature of the fluid medium at an inlet of the combustor; and
a control unit configured to control the cooling mechanism based on the temperature measured by the temperature measuring unit so as to cool the fluid medium to be within a preset temperature range.

4. The gasified-gas generation system according to claim 2, comprising:

a temperature measuring unit configured to measure a temperature of the fluid medium at an inlet of the combustor; and
a control unit configured to control the cooling mechanism based on the temperature measured by the temperature measuring unit so as to cool the fluid medium to a preset temperature range.

5. The gasified-gas generation system according to claim 1, comprising a loop seal provided between the gasifier and the combustor and configured to prevent any one or both of an outflow of the gasified gas generated by the gasifier to the combustor and an inflow of a gas from the combustor to the gasifier,
wherein the cooling mechanism cools the fluid medium in the loop seal.

6. The gasified-gas generation system according to claim 2, comprising a loop seal provided between the gasifier and the combustor and configured to prevent any one or both of an outflow of the gasified gas generated by the gasifier to the combustor and an inflow of a gas from the combustor to the gasifier,
wherein the cooling mechanism cools the fluid medium in the loop seal.

7. The gasified-gas generation system according to claim 3, comprising a loop seal provided between the gasifier and the combustor and configured to prevent any one or both of an outflow of the gasified gas generated by the gasifier to the combustor and an inflow of a gas from the combustor to the gasifier,
wherein the cooling mechanism cools the fluid medium in the loop seal.

8. The gasified-gas generation system according to claim 4, comprising a loop seal provided between the gasifier and the combustor and configured to prevent any one or both of an outflow of the gasified gas generated by the gasifier to the combustor and an inflow of a gas from the combustor to the gasifier , wherein the cooling mechanism cools the fluid medium in the loop seal.

9. The gasified-gas generation system according to any one of claims 1 to 8, wherein: the cooling mechanism exchanges heat between water and the fluid medium to cool the fluid medium and generate steam; the cooling mechanism includes an introduction unit that introduces the steam generated by the cooling mechanism into the gasifier; and the gasification material in the gasifier is gasified by the steam.

FIG. 1

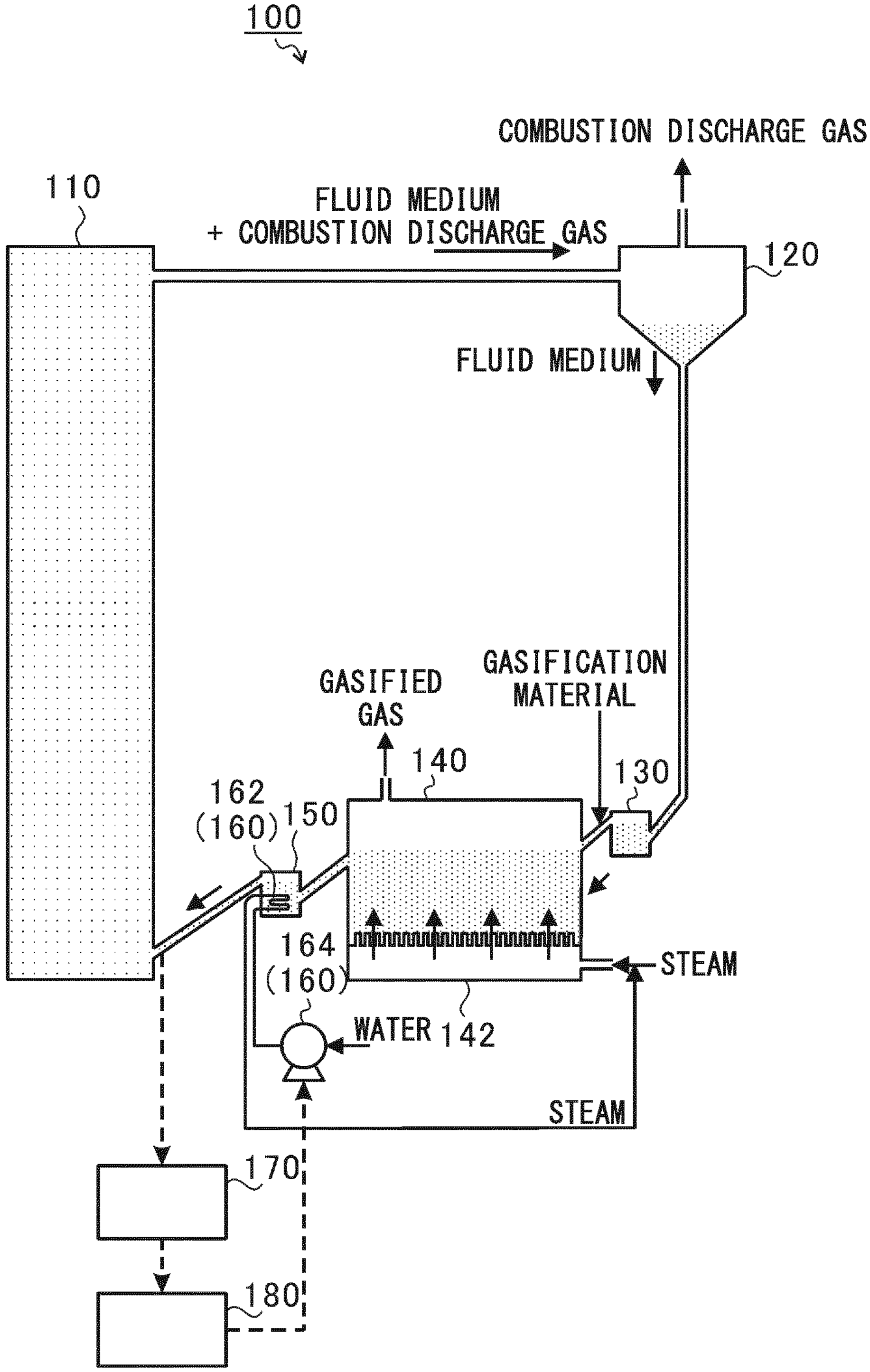
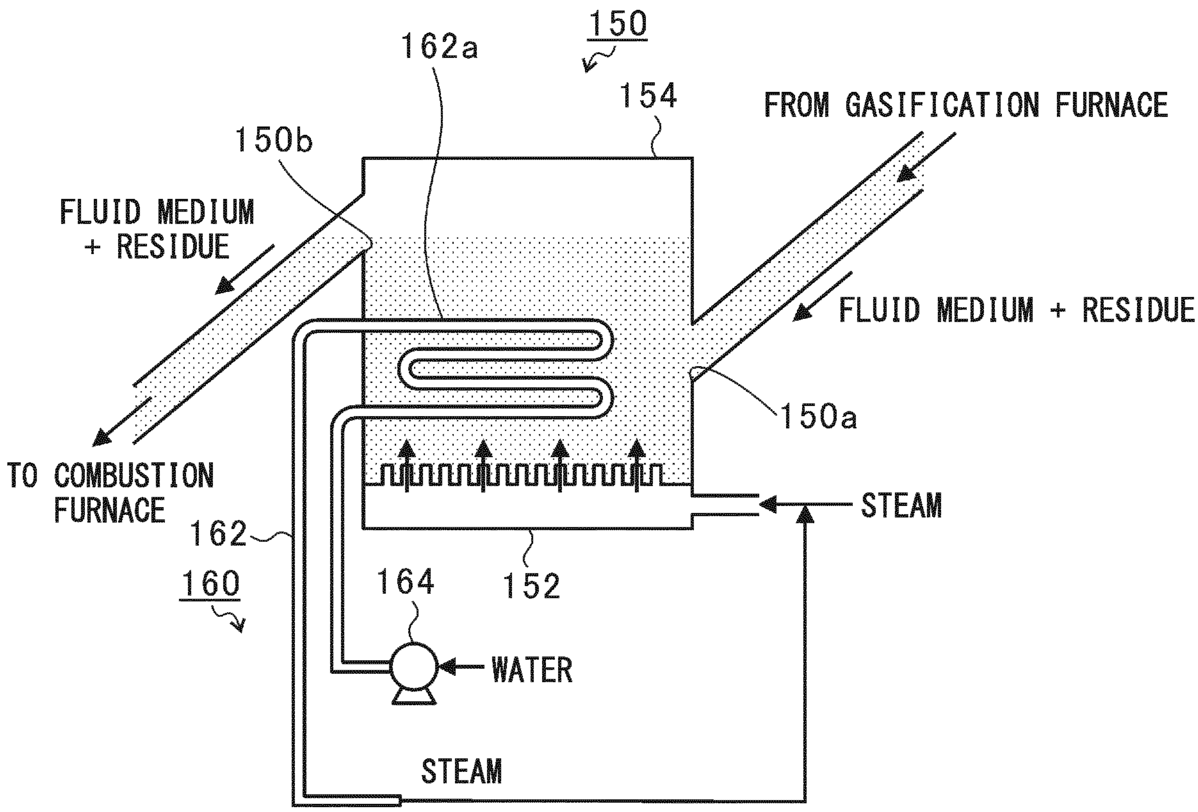

100
COMBUSTION DISCHARGE GAS
110
FLUID MEDIUM
+ COMBUSTION DISCHARGE GAS
120
FLUID MEDIUM
GASIFICATION
MATERIAL
GASIFIED
GAS
140
130
162
(160)
150
164
(160)
STEAM
WATER
142
STEAM
170
180

FIG. 2


150
162a
154
FROM GASIFICATION FURNACE
150b
FLUID MEDIUM
+ RESIDUE
FLUID MEDIUM + RESIDUE
150a
TO COMBUSTION
FURNACE
STEAM
162
160
164
152
WATER
STEAM

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/057554

A. CLASSIFICATION OF SUBJECT MATTER
C10J3/54(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C10J3/54

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2014
Kokai Jitsuyo Shinan Koho	1971-2014	Toroku Jitsuyo Shinan Koho	1994-2014

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 2012-57126 A (IHI Corp.), 22 March 2012 (22.03.2012), paragraphs [0025], [0033] (Family: none)	1,2,5,6 7,8
X	JP 2005-41959 A (Ishikawajima-Harima Heavy Industries Co., Ltd.), 17 February 2005 (17.02.2005), paragraphs [0016], [0020] (Family: none)	1,9
X	JP 11-181450 A (Ebara Corp.), 06 July 1999 (06.07.1999), paragraph [0021] & US 2005/0144844 A1 & EP 1043385 A1 & WO 1999/031202 A1 & CA 2314986 A & KR 10-2005-0117592 A	1

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
01 May, 2014 (01.05.14)	13 May, 2014 (13.05.14)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/057554

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2005-207643 A (JFE Engineering Corp.), 04 August 2005 (04.08.2005), paragraph [0045] (Family: none)	3,4

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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- JP 3933105 B **[0007]**
- JP 2005041959 A **[0007]**
- JP H0735322 B **[0007]**
- JP 2003176486 A **[0007]**
- JP 2013046893 A **[0007]**