

DESCRIPTION

Title of Invention

COMBUSTION DEVICE, AND COMBUSTION METHOD

Technical Field

[0001]

The present invention relates to a combustion device that causes combustion.

Background Art

[0002]

A bubbling fluidized bed (BFB) boiler or a circulating fluidized bed (CFB) boiler that combusts a fuel with a fluidized layer or a fluidized bed formed by a fluid material such as silica sand fluidized in a combustion chamber as a medium is known as a combustion device that causes combustion. PTL 1 discloses the CFB boiler.

Citation List

Patent Literature

[0003]

[PTL 1] Japanese Unexamined Patent Publication No.

2012-255612

Summary of Invention

Technical Problem

[0004]

Since the BFB boiler or the CFB boiler can realize high combustion efficiency with a high-temperature fluid material fluidized in the combustion chamber as a medium, the BFB boiler or the CFB boiler is suitable for combustion of an unstable quality fuel, such as biomass (biofuel), sludge (slurry), and a waste material (waste paper, waste plastic, waste tires, or the like), or a flame-retardant fuel. However, since all the fuels have carbon as a main component, greenhouse gases such as carbon dioxide are generated during combustion, and there is a possibility in which global warming aggravates further.

[0005]

The present invention is devised in view of such circumstances, and an object thereof is to provide a combustion device that can reduce generation of greenhouse gases.

Solution to Problem

[0006]

According to an aspect of the present invention, in order to solve the problem, there is provided a combustion device including a combustion chamber that causes

combustion and a hydrogen storing material supply unit that supplies a hydrogen storing material, which is capable of releasing stored hydrogen during heating, to the combustion chamber. Even when the hydrogen released from the hydrogen storing material combusts in the combustion chamber, since water is mainly generated, generation of greenhouse gases can be reduced.

[0007]

According to another aspect of the present invention, there is provided a combustion method. The method includes a hydrogen storing material supply step of supplying a hydrogen storing material, which is capable of releasing stored hydrogen during heating, to a combustion chamber and a combustion step of combusting the hydrogen released from the hydrogen storing material in the combustion chamber.

[0008]

Any combination of the components described above and substitutions of expressions of the present invention between methods, devices, systems, recording media, computer programs, and the like are also effective as aspects of the present invention.

Advantageous Effects of Invention

[0009]

With the present invention, generation of greenhouse gases can be reduced in the combustion device.

Brief Description of Drawings

[0010]

Fig. 1 shows an overall configuration of a circulating fluidized bed boiler.

Fig. 2 shows an overall configuration of a rotary kiln.

Description of Embodiments

[0011]

Hereinafter, an embodiment for carrying out the present invention will be described in detail with reference to the drawings. In the description and drawings, the same or equivalent components, members, and processing will be assigned with the same reference symbols, and redundant description thereof will be omitted as appropriate. The scales and shapes of shown parts are set for convenience in order to make the description easy to understand and are not to be understood as limiting unless stated otherwise. The embodiment is merely an example and does not limit the scope of the present invention. Respective characteristics and combinations thereof to be

described in the embodiment are not necessarily essential to the invention.

[0012]

A combustion device of the present invention is any device that causes combustion. For example, in a case where the combustion device is configured as a boiler, the combustion device can be configured as a BFB boiler or a CFB boiler that combusts a fuel containing hydrogen released from a hydrogen storing material with a fluidized layer or a fluidized bed formed by a fluid material such as silica sand fluidized in a combustion chamber and a granular hydrogen storing material to be described later as a medium. In addition, the combustion device can also be configured as a rotary kiln. In the present embodiment, configuration examples of the CFB boiler and the rotary kiln will be specifically described.

[0013]

Fig. 1 shows an overall configuration of a circulating fluidized bed boiler (CFB boiler) that is the combustion device. The CFB boiler includes a combustion section 1 that supplies a fuel containing hydrogen released from a hydrogen occluding alloy into a furnace 11 in which a fluid material such as silica sand and a granular hydrogen occluding alloy is fluidized and that combusts the fuel, a vapor generation section 2 that generates vapor from water

with heat generated by the combustion section 1, a fluid material circulation section 3 that is a circulation section which collects the fluid material came out of the furnace 11 and which returns the fluid material into the furnace 11, a heat transfer section 4 that heats air to be supplied to the combustion section 1, water to be supplied to the vapor generation section 2, and vapor to be generated by the vapor generation section 2 with a high-temperature exhaust gas of the combustion section 1, a dust collection device 5 that separates and collects soot or dust in the exhaust gas from the heat transfer section 4, and a chimney 6 that releases the exhaust gas cleaned by the dust collection device 5 to the atmosphere.

[0014]

The combustion section 1 includes the furnace 11 which is the combustion chamber. The furnace 11 has a tubular shape that is long in a vertical direction and has a tapered bottom portion in order to increase the density of a solid fuel including a hydrogen occluding alloy or a fluid material to enable efficient combustion. The bottom portion of the furnace 11 may not have a tapered shape, and the furnace 11 may be formed to have a substantially constant tubular sectional shape from a top portion to the bottom portion. A region of the bottom portion of the furnace 11 shown by "A" shows a fluidized layer (also

called a fluidized bed or a sand layer) formed by a high-density fluid material. In a fluidized layer A, powdery, granular, and lumpy fluid materials such as silica sand and a hydrogen occluding alloy are fluidized by air which is a fluidizing fluid supplied from the bottom portion of the furnace 11. Hydrogen that is a fuel released from a solid fuel such as coal and biomass input into the fluidized layer A or a hydrogen occluding alloy input into the fluidized layer A efficiently combusts by repeatedly coming into contact with a high-temperature fluid material and air so as to be agitated in the fluidized layer A.

[0015]

Since a fluid material rises in the furnace 11 due to an upward airflow generated by combustion, the fluid material is also present in a free board B that is a space above the fluidized layer A. The density of the fluid material in the free board B is lower than the density of the fluid material in the fluidized layer A and decreases toward an upper side of the furnace 11. In the free board B, a fuel that has not completely combusted in the fluidized layer A combusts while coming into contact with a floating fluid material. Although silica sand has been given as an example of the fluid material, any fluid material may be used insofar as the fluid material functions as a medium transferring heat to a fuel while

maintaining a solid state without combustion even in the high-temperature furnace 11 and being fluidized and may be, for example, other types of sand, stones such as limestone, and ash. Since a hydrogen storing material such as a hydrogen occluding alloy that is a carrier of hydrogen which is a fuel also functions as a fluid material, in a case where a sufficient amount of hydrogen storing material is supplied to the furnace 11 in realizing the function of the fluidized layer A, other fluid materials such as silica sand may not be supplied to the furnace 11. As described above, with the hydrogen storing material such as a hydrogen occluding alloy, a fuel (hydrogen) and a fluid material (hydrogen storing material before and after hydrogen release) can be supplied to the furnace 11 all at once.

[0016]

At the bottom portion of the furnace 11, a perforated plate (also called a dispersion plate) 121 that is a fluid permeation portion configured by a porous material through which a fluid containing air permeates is provided. An air box 122 that is a space immediately below the perforated plate 121 configures a fluidizing fluid supply unit (air supply unit) that supplies pressurized air supplied from a first blower 71, which is an air blower, via a first flow rate control valve 71A into the furnace 11 via the

perforated plate 121. The pressurized air supplied to the bottom portion of the furnace 11 by the air box 122 fluidizes a fluid material to form the fluidized layer A and is used in combustion of a fuel in the fluidized layer A or the free board B.

[0017]

A fluid fuel that does not contain carbon or a carbon-free fuel, such as ammonia and hydrogen, may be supplied from the air box 122 into the furnace 11 via the perforated plate 121 together with pressurized air and may combust in the fluidized layer A or the free board B. By partially or entirely replacing a carbon containing fuel of the related art such as coal, biomass, sludge, and a waste material with a carbon-free fuel, the generation of greenhouse gases in the combustion device such as a CFB boiler can be reduced. As will be described later, using a hydrogen storing material such as a hydrogen occluding alloy as a solid fuel leads to replacement of a fuel of the related art with a clean fuel having a small emission amount of the greenhouse gases.

[0018]

In order to promote combustion of a fuel in the free board B and to suppress generation of harmful substances such as dioxin and carbon monoxide caused by incomplete combustion, a second blower 72 that is provided in addition

to the first blower 71 supplies pressurized air into the free board B via a second flow rate control valve 72A. Although the fluid permeation portion has been described with the perforated plate 121 given as an example in Fig. 1, the fluid permeation portion may be any fluid permeation portion insofar as a fluid material can be fluidized in the fluidized layer A or may be formed of, for example, multiple plates in which a slit for supplying a fluidizing fluid into the furnace 11 is formed.

[0019]

In order to circulate a fluid material in the fluidized layer A, an external circulation mechanism 13 that includes a circulation path outside the furnace 11 is provided. The external circulation mechanism 13 includes an extraction pipe 131 that communicates with the bottom portion of the furnace 11 and that can extract some of the fluid material in the fluidized layer A, an opening and closing valve 132 that controls opening and closing of the extraction pipe 131 and that can regulate a flow rate of the fluid material, that is, an amount of the fluid material extracted by the extraction pipe 131, a fluid material conveyor 133 such as a bucket conveyor that transports the fluid material extracted by the extraction pipe 131 upward, a fluid material silo 134 that is provided at an outer periphery of the furnace 11, which corresponds

to an upper portion of the fluidized layer A, and that receives the fluid material transported by the fluid material conveyor 133, and a fluid material reinput portion 135 that reinputs the fluid material stored in the fluid material silo 134 into the furnace 11.

[0020]

The extraction pipe 131, the opening and closing valve 132, the fluid material conveyor 133, the fluid material silo 134, and the fluid material reinput portion 135 configure the circulation path for the fluid material, which connects a space between a bottom surface and a side surface of the furnace 11 to the outside of the furnace 11. That is, the fluid material extracted from the bottom surface of the furnace 11 by the extraction pipe 131 is reinput from the side surface of the furnace 11 by the fluid material reinput portion 135 into the fluidized layer A via the opening and closing valve 132, the fluid material conveyor 133, and the fluid material silo 134. As will be described later, a collection unit 17 for partially or entirely collecting a hydrogen storing material such as a hydrogen occluding alloy contained in a fluid material circulating in the circulation path is provided.

[0021]

At a furnace wall which is a side wall of the furnace 11, a hydrogen storing material supply unit 14 that

supplies a hydrogen storing material such as a hydrogen occluding alloy into the furnace 11, a fuel supply unit 15 that supplies a fuel different from the hydrogen storing material into the furnace 11, and a start-up unit 16 that starts up the CFB boiler are provided. Since the hydrogen storing material supply unit 14 supplies the hydrogen storing material that also functions as a fluid material, although not shown, a fluid material supply unit that supplies other fluid materials such as silica sand into the furnace 11 may be provided in addition to the hydrogen storing material supply unit 14. The hydrogen storing material supply unit 14 includes a funnel-shaped hopper 141 that stores the hydrogen storing material, a crushing unit 142 that crushes the hydrogen storing material discharged from a bottom portion of the hopper 141 into a granular form, and a feeder 143 that supplies the hydrogen storing material crushed by the crushing unit 142 into the furnace 11.

[0022]

A hydrogen storing material is a material that can release stored hydrogen during heating, and a hydrogen occluding alloy is given as an example thereof. The hydrogen occluding alloy (a hydrogen storage alloy, a hydrogen absorbing alloy, and a metal hydride) is an alloy that reacts with hydrogen to occlude or store hydrogen in

the form of a metal hydrogen compound and that has a property of releasing hydrogen when heated. An AB₂ type (based on alloys of transition elements such as titanium, manganese, zirconium, and nickel), an AB₅ type such as LaNi₅ and ReNi₅ (based on alloys containing five transition elements such as nickel, cobalt, and aluminum for one rare earth element, niobium, and zirconium), a titanium-iron (Ti-Fe) type, a vanadium (V) type, a magnesium (Mg) type, a palladium (Pd) type, a calcium (Ca) type, and the like are known.

[0023]

Among such hydrogen occluding alloys, the Ti-Fe type, which is available with a relatively low cost, needs to be placed in a high-temperature environment of approximately 450°C in order to efficiently occlude or release hydrogen and is not widely used because of its complexity. On the contrary, since the hydrogen occluding alloy can be naturally heated by the furnace 11 (in order to suppress generation of harmful substances such as dioxin and carbon monoxide caused by incomplete combustion, the furnace 11 including the free board B is generally maintained at approximately 800°C or more) having a high temperature of approximately 900°C during normal operation in the present embodiment, release and combustion of hydrogen that is a fuel can be realized in the furnace 11 all at once. As

described above, the carbon containing fuel of the related art such as coal, biomass, sludge, and waste material can be partially or entirely replaced with a clean fuel having a small emission amount of greenhouse gases, such as the hydrogen occluding alloy or hydrogen that is a carbon-free fuel.

[0024]

In a case where a sufficient amount of fuel (hydrogen) for combustion in the furnace 11 is supplied from the hydrogen storing material supply unit 14, the fuel supply unit 15 to be described later, which supplies a fuel different from a hydrogen storing material into the furnace 11, may not be provided. In addition, the hydrogen storing material is not limited to a hydrogen occluding alloy and may be a material that can release stored hydrogen during heating. For example, there is a possibility in which an organic polymer or an organic polymer that is disclosed in International Publication No. 2015/005280 and that can store hydrogen can also be used as the hydrogen storing material of the present embodiment.

[0025]

The crushing unit 142 crushes a hydrogen storing material such as a hydrogen occluding alloy before being supplied to the furnace 11 into a granular form. The size of a hydrogen occluding alloy suitable for transportation

to the CFB boiler or the hopper 141 and the size of a hydrogen occluding alloy suitable for hydrogen release in the furnace 11 and a function as a fluid material before and after hydrogen release are different from each other in some cases, and a hydrogen occluding alloy is crushed into granules having a granular diameter suitable for the latter by the crushing unit 142. In a case where there is no large difference between the granular diameters suitable for the former and the latter, the crushing unit 142 may not be provided. Herein, the terms "granule", "granular", "granular diameter" do not refer to a specific size or dimension, the size or the dimension does not matter insofar as a hydrogen storing material supplied into the furnace 11 can release hydrogen which is a fuel. For example, the terms "lump", "lumpy", and "lump diameter" used in relatively large granules and the terms "powder", "powdery", and "powder diameter" used in relatively small granules are included in "granule", "granular", and "granular diameter" in the present embodiment. A required amount of granular hydrogen storing material crushed by the crushing unit 142 is input into the furnace 11 by the feeder 143 that can control the rotation speed.

[0026]

The fuel supply unit 15 supplies a solid fuel different from a hydrogen storing material into the furnace

11. The fuel supply unit 15 includes a funnel-shaped hopper 151 that stores the solid fuel and a feeder 152 that supplies the solid fuel discharged from a bottom portion of the hopper 151 into the furnace 11. By controlling the rotation speed of the feeder 152, a required amount of solid fuel is input into the furnace 11.

[0027]

A solid fuel supplied by the fuel supply unit 15 into the furnace 11 is not particularly limited, but examples thereof include various types of coal, such as smokeless coal, bitumen coal, and brown coal, biomass, sludge, and a waste material. In the CFB boiler, since high combustion efficiency can be realized with a high-temperature fluid material fluidized in the furnace 11 as a medium, a low-quality fuel or a flame-retardant fuel can also efficiently combust. The solid fuel described above is carbon containing fuel that contains carbon, but the fuel supply unit 15 may supply a fluid fuel that does not contain carbon or a carbon-free fuel, such as ammonia and hydrogen, in addition to or instead of the solid fuel, into the furnace 11.

[0028]

The start-up unit 16 that starts the CFB boiler includes a start-up fuel storage unit 161, a start-up fuel control valve 162, and a start-up burner 163. The start-up

fuel storage unit 161 stores a heavy oil that is a carbon containing fuel. The start-up fuel control valve 162 controls a supply amount of heavy oil from the start-up fuel storage unit 161 to the start-up burner 163. Specifically, the start-up fuel control valve 162 is brought into an open state when starting up the CFB boiler and supplies the heavy oil stored in the start-up fuel storage unit 161 to the start-up burner 163. The start-up burner 163 heats a fluid material in the fluidized layer A with a flame caused by combustion of the heavy oil supplied from the start-up fuel control valve 162. Since the start-up burner 163 is provided to be inclined downward, the surface of the fluidized layer A formed by the fluid material is directly heated, and temperatures of the fluidized layer A and the inside of the furnace 11 efficiently increase. In this manner, the start-up burner 163 is also called an on-sand burner since the sand-like fluidized layer A is heated from above.

[0029]

After start-up of the CFB boiler in which temperatures of the fluidized layer A and the inside of the furnace 11 have sufficiently risen, specifically after release and combustion of hydrogen from a hydrogen storing material in the fluidized layer A have become possible (after the fluidized layer A has become a temperature sufficiently

higher than approximately 450°C required for release of hydrogen in a Ti-Fe type hydrogen occluding alloy described above), the start-up fuel control valve 162 is brought into a closed state and stops supply of a heavy oil to the start-up burner 163. In the subsequent normal operation state, hydrogen released from the hydrogen storing material supplied from the hydrogen storing material supply unit 14 and a fuel different from a hydrogen storing material supplied from the fuel supply unit 15 combust in the high-temperature furnace 11. Although the hydrogen storing material after releasing hydrogen which is a fuel is fluidized in the furnace 11 and functions as a fluid material which mediates combustion of the fuel, the hydrogen storing material that exceeds a required amount is collected by the collection unit 17 provided in the circulation path for the fluid material in the external circulation mechanism 13.

[0030]

The collection unit 17 that collects a hydrogen storing material from the bottom portion of the furnace 11 includes a separation unit 171 that separates and collects an excess hydrogen storing material from a fluid material circulating in the external circulation mechanism 13. The separation unit 171 can separate out materials with desired features using differences in mechanical or dynamic

properties, such as mass, density, a granular diameter, and a shape, and physical properties, such as magnetism. For example, even in a case where the fluid material circulating in the external circulation mechanism 13 contains a fluid material other than a hydrogen occluding alloy such as silica sand or ash or soot generated by combustion in the furnace 11, only the hydrogen occluding alloy can be efficiently separated out and collected. In particular, in a case of a hydrogen occluding alloy having magnetism such as a Ti-Fe type, only the hydrogen occluding alloy having magnetism can be magnetically and efficiently separated out and collected by a magnetic separation unit 1711. In addition, even in a case where the fluid material circulating in the external circulation mechanism 13 contains a hydrogen occluding alloy having a different granular diameter, only the hydrogen occluding alloy having a desired granular diameter range can be efficiently separated out and collected. After the hydrogen occluding alloy after hydrogen release, which is separated out and collected in this manner, is transported to a hydrogen filling facility (not shown) and is refilled with hydrogen, the hydrogen occluding alloy is reinput into the hopper 141 of the hydrogen storing material supply unit 14 and is reused as a hydrogen fuel.

With the configuration above, the CFB boiler can be efficiently operated by inputting a hydrogen storing material that functions as a hydrogen fuel source and a fluid material into the furnace 11, and an emission amount of greenhouse gases can be reduced by replacing the existing carbon containing fuel with a hydrogen fuel.

[0032]

The combustion section 1 of the CFB boiler has been described in detail hereinbefore. Next, a configuration other than the combustion section 1 of the CFB boiler will be described. The vapor generation section 2 includes a drum 21 that stores water for generating vapor, a water supply pipe 22 through which water is supplied to the drum 21, a water pipe 23 through which the water in the drum 21 is introduced into the high-temperature furnace 11 and is heated, and a vapor pipe 24 through which vapor generated from the water heated in the water pipe 23 is exhausted from the drum 21 as an output of the CFB boiler. The water supply pipe 22 configures a coal economizer that preheats water supply by meandering in the heat transfer section 4 through which a high-temperature exhaust gas of the combustion section 1 passes, and the vapor pipe 24 configures a superheater that superheats the vapor by meandering in the heat transfer section 4 through which the high-temperature exhaust gas of the combustion section 1

passes. Similarly, pressurized air supplied into the furnace 11 by the first blower 71 and the second blower 72 is also preheated with the high-temperature exhaust gas in the heat transfer section 4.

[0033]

The fluid material circulation section 3 includes a cyclone 31 that separates and collects a fluid material containing a granular hydrogen occluding alloy from an exhaust gas exhausted from the upper portion of the furnace 11 and a seal pot 32 that returns the fluid material collected by the cyclone 31 into the furnace 11. The cyclone 31 is a cyclone-type powder separator that has a substantially cylindrical upper portion and a substantially conical lower portion and generates an airflow that spirally descends along an inner wall. The fluid material such as the granular hydrogen occluding alloy contained in the exhaust gas from the furnace 11 is collected by coming into contact with the inner wall of the cyclone 31 and falling when descending spirally along the airflow.

[0034]

The seal pot 32 provided below the cyclone 31 is filled with a fluid material, and backflow of an unburned gas or the like from the furnace 11 to the cyclone 31 is prevented. The fluid material such as a granular hydrogen occluding alloy filling the seal pot 32 gradually returns

into the furnace 11 in the form of being pushed out by the weight of a fluid material newly collected by the cyclone 31.

[0035]

Fig. 2 shows an overall configuration of a rotary kiln 100 that is a combustion device. The rotary kiln 100 includes a rotary furnace 200 which is the combustion chamber, a secondary combustion chamber 300, a communication chute (connecting part) 400, and an electric furnace 600 which is the collection unit. The rotary kiln 100 is the combustion device that separates a workpiece W containing a metal into slag and the metal with the rotary furnace 200 and the electric furnace 600 and that collects the metal. The workpiece W containing a metal is, for example, a substrate of an electronic device or the like, wire scraps, and copper, gold, and silver slag. The rotary kiln 100 can collect the metal such as copper (Cu), gold (Au), silver (Ag), lead (Pb), tin (Sn), and palladium (Pd) from the workpiece W. In addition, as will be described later, in a case where a hydrogen occluding alloy (a hydrogen storing material H), which is a hydrogen fuel source, is input into the rotary kiln 100 in addition to the workpiece W, the hydrogen occluding alloy can also be separated out and collected together with the metal.

[0036]

The rotary furnace 200 that combusts and melts the workpiece W is formed in a cylindrical shape, and an inner wall thereof is lined with a fireproof material. The workpiece W input into the rotary furnace 200 combusts or melts at approximately 1,400°C to 1,500°C with hot air from a burner 10. Although a fuel oil is supplied from the fuel supply unit to the burner 10 together with air, since hydrogen released from the hydrogen storing material H input into the rotary furnace 200 together with the workpiece W can also be used as a fuel in the present embodiment, a used amount of fuel oil generating greenhouse gases can be reduced.

[0037]

The rotary furnace 200 during combustion processing is driven to be rotatable around a cylindrical shaft and efficiently combusts the workpiece W with hydrogen released from the hydrogen storing material H while agitating the workpiece W and the hydrogen storing material H therein. Since a rotary shaft of the rotary furnace 200 is provided to be inclined downward, the workpiece W is fluidized together with the hydrogen storing material H from an inlet 2a on a high side to an outlet 2b on a low side while combusting. An input chute 7 for inputting the workpiece W and the hydrogen storing material H and an input pusher 8 for pushing the input workpiece W and the input hydrogen

storing material H into the rotary furnace 200 are provided on an inlet 2a side of the rotary furnace 200.

[0038]

In the rotary furnace 200, molten materials of the combusted workpiece W and the combusted hydrogen storing material H (hydrogen occluding alloy) are separated into the slag S and a metal M1 due to a specific gravity difference. In addition, a combustible material in the workpiece W is thermally decomposed into a gas. The metal M1 (including a hydrogen occluding alloy) separated out from the workpiece W and the hydrogen storing material H is brought into a molten state or a semi-molten state and accumulates on a lower layer side, and oxidation is prevented since a surface thereof is covered with the slag S. A tapping nozzle (discharge port) 9 that is a collection unit which can discharge the molten metal M1 (including a hydrogen occluding alloy) accumulated in a bottom portion of the rotary furnace 200 downward is provided in a peripheral wall 2c configuring the bottom portion (a lower portion of Fig. 2) of the cylindrical rotary furnace 200 having a substantially horizontal direction as an axial direction.

[0039]

The tapping nozzle 9 is maintained in a closed state while the rotary furnace 200 rotates and combusts or melts

the workpiece W and the hydrogen storing material H. After combustion or melting of the workpiece W and the hydrogen storing material H is completed and the rotation of the rotary furnace 200 is stopped, by bringing the tapping nozzle 9 into an open state, the metal M1 accumulated on the lower layer side of the slag S can be separated out and collected from the tapping nozzle 9 in the bottom portion of the rotary furnace 200. The metal M1 or the slag S that cannot be separated out and collected in the tapping nozzle 9 is input from a bottom portion of the secondary combustion chamber 300 into the electric furnace 600.

[0040]

As the secondary combustion chamber 300 connected to the outlet 2b at a right end of the rotary furnace 200 further combusts a gas generated in the rotary furnace 200, dioxin, malodorous substances, and the like are decomposed and supplied to an exhaust gas processing facility. In the secondary combustion chamber 300, a secondary combustion burner 110 near the outlet 2b of the rotary furnace 200 is provided, and a supply unit or a stirring blower that supplies urea, air, and SCC temperature controlled water is provided thereabove. Although a fuel oil is supplied from the fuel supply unit to the burner 110 together with air, since the workpiece W or a gas in the rotary furnace 200 can effectively combust with hydrogen released from the

hydrogen storing material H input into the rotary furnace 200 in the present embodiment, a used amount of fuel oil in the secondary combustion burner 110 can be reduced.

[0041]

The communication chute 400 extending downward from a connecting part of the rotary furnace 200 and the secondary combustion chamber 300 is a communication passage that connects the rotary furnace 200 and the electric furnace 600 to each other. A wall of the communication chute 400 is provided at a position that does not come into contact with the slag S discharged from the outlet 2b of the rotary furnace 200. For this reason, the slag S discharged from the outlet 2b of the rotary furnace 200 falls without coming into contact with the wall of the communication chute 400 and is input into the electric furnace 600. On the other hand, in a case the slag S is adhered to the wall of the communication chute 400, an emergency burner 120 for melting the slag S is provided.

[0042]

The electric furnace 600 is connected to the rotary furnace 200 via the communication chute 400, and a metal including a hydrogen occluding alloy is separated from molten materials of the workpiece W and the hydrogen storing material H, which are input into the rotary furnace 200, through heating processing using electricity.

Specifically, the metal including the hydrogen occluding alloy remaining in the slag S separated in the rotary furnace 200 can be collected in the electric furnace 600. The electric furnace 600 configured as an electric resistance heating furnace includes a tank 20 that retains the molten materials and that separates a metal M2, including a hydrogen occluding alloy from the slag S, and electrodes 21A, 21B, and 21C that heat the slag S with electricity. In the tank 20 heated by the electrodes 21A, 21B, and 21C, a layer of the molten metal M2 including the hydrogen occluding alloy is formed on a lower side, and a layer of the molten slag S is formed on an upper side.

[0043]

The electric furnace 600 is provided with a coke supply device 22A, and coke which is a reducer is supplied into the tank 20 via a supply line 22B. Although the slag S, which has undergone combustion processing, that is, oxidation processing in the rotary furnace 200, contains a metal oxide, the metal oxide can be reduced to the metal M2 through reducing reaction of coke and be collected. In addition to coke, coal, waste carbon, or the like may be used as a reducer. As the tank 20 of such an electric furnace 600 is maintained at approximately 1,400°C to 1,500°C by the electrodes 21A, 21B, and 21C as in the rotary furnace 200 and the slag S is retained for

approximately 3 to 6 hours, substantially the entire amount of metal component in the slag S can be collected as the metal M2 (including a hydrogen occluding alloy).

Specifically, the metal M2 including the hydrogen occluding alloy is discharged from a metal collection line 230 connected to a lower portion of the tank 20, and the slag S that does not contain the metal M2 is discharged from a slag collection line 240 connected to an upper portion of the tank 20.

[0044]

With the configuration above, combustion efficiency of the rotary kiln 100 can be improved by inputting the hydrogen storing material H functioning as a hydrogen fuel source into the rotary furnace 200, and an emission amount of greenhouse gases can be reduced by replacing a fuel oil, which is the existing carbon containing fuel, with a hydrogen fuel. In addition, in a case where the hydrogen storing material H is a hydrogen occluding alloy, the hydrogen occluding alloy can be efficiently collected together with the metals M1 and M2 by the tapping nozzle 9 or the electric furnace 600, which is the collection unit.

[0045]

The present invention has been described hereinbefore based on the embodiment. It is clear for those skilled in the art that the embodiment is an example, various

modification examples are possible for a combination of each component and each processing process, and such modification examples are also within the scope of the present invention.

[0046]

Although the CFB boiler has been described as an example of the boiler in Fig. 1, the present invention can also be applied to a bubbling fluidized bed boiler (BFB boiler). The configuration of the BFB boiler is the same as the CFB boiler except that the fluid material circulation section 3 that collects a fluid material which has come out of the furnace 11 and that returns the fluid material into the furnace 11 is not included.

[0047]

A functional configuration of each device described in the embodiment can be realized by a hardware resource or a software resource or by cooperation of the hardware resource and the software resource. A processor, a ROM, a RAM, or other LSI can be used as the hardware resource. A program such as an operating system and an application can be used as the software resource.

Industrial Applicability

[0048]

The present invention relates to a combustion device that causes combustion.

Reference Signs List

[0049]

1 Combustion section

3 Fluid material circulation section

9 Tapping nozzle

10 Burner

11 Furnace

14 Hydrogen storing material supply unit

15 Fuel supply unit

17 Collection unit

31 Cyclone

100 Rotary kiln

110 Burner

120 Burner

142 Crushing unit

171 Separation unit

200 Rotary furnace

300 Secondary combustion chamber

600 Electric furnace

1711 Magnetic separation unit

CLAIMS

1. A combustion device comprising:
a combustion chamber that causes combustion; and
a hydrogen storing material supply unit that supplies
a hydrogen storing material, which is capable of releasing
stored hydrogen during heating, to the combustion chamber.
2. The combustion device according to claim 1,
wherein the hydrogen storing material is a hydrogen
occluding alloy.
3. The combustion device according to claim 1 or 2,
wherein the hydrogen storing material is granular.
4. The combustion device according to claim 3,
further comprising:
a crushing unit that crushes the hydrogen storing
material before being supplied to the combustion chamber
into a granular form.
5. The combustion device according to claim 3,
further comprising:
a circulation section that collects the granular
hydrogen storing material which has come out of the

combustion chamber and that returns the granular hydrogen storing material into the combustion chamber.

6. The combustion device according to claim 1 or 2, further comprising:

a collection unit that collects the hydrogen storing material from a bottom portion of the combustion chamber.

7. The combustion device according to claim 6,

wherein in a case where the hydrogen storing material has magnetism, the collection unit further includes a magnetic separation unit that magnetically separates out the hydrogen storing material.

8. The combustion device according to claim 1 or 2,

further comprising:

a fuel supply unit that supplies a fuel different from the hydrogen storing material to the combustion chamber.

9. The combustion device according to claim 1 or 2,

wherein the combustion device is at least any one of a circulating fluidized bed boiler, a bubbling fluidized bed boiler, and a rotary kiln.

10. A combustion method comprising:

a hydrogen storing material supply step of supplying a hydrogen storing material, which is capable of releasing stored hydrogen during heating, to a combustion chamber;
and

a combustion step of combusting the hydrogen released from the hydrogen storing material in the combustion chamber.