DESCRIPTION

TITLE OF INVENTION:

COMBUSTION FACILITY AND CONTROL METHOD

TECHNICAL FIELD

[0001]

The present disclosure relates to a combustion facility and a control method.

Priority is claimed on Japanese Patent Application No. 2024-062780, filed April 9, 2024, the content of which is incorporated herein by reference.

BACKGROUND ART

[0002]

Patent Document 1 discloses an incineration device in which an oxygen concentration in a rotary kiln is controlled to a desired oxygen concentration. Patent Document 2 discloses an incinerator that suppresses an increase in NOx concentration in an exhaust gas discharged from a secondary combustion chamber.

Prior Art Documents

Patent Documents

[0003]

Patent Document 1: Japanese Patent No. 5430210

Patent Document 2: Japanese Patent No. 7199305

SUMMARY OF INVENTION

Technical Problem

[0004]

However, in the incineration device disclosed in Patent Document 1 and the incinerator disclosed in Patent Document 2, it is desired to realize more appropriate combustion.

[0005]

The present disclosure has been made to solve the above-described problems, and an object of the present disclosure is to provide a combustion facility and a control method capable of realizing appropriate combustion.

Solution to Problem

[0006]

In order to solve the above-described problems, a combustion facility according to the present disclosure includes a furnace into which gas after combustion flows, a furnace body including a drying stage, a combustion stage, and a post-combustion stage and configured to convey an object to be incinerated while combusting the object to be incinerated, the furnace body including, in a case where an upstream side in a conveyance direction of the object to be incinerated is referred to as front and a downstream side in the conveyance direction is referred to as rear, a front ceiling portion extending forward from the furnace, a rear ceiling portion extending rearward from the furnace, and a rear wall extending downward from a rear end portion of the rear ceiling portion, a first nozzle provided in a region of the rear ceiling portion rearward of a center of the rear ceiling portion in the conveyance direction or in the rear wall and configured to discharge a first gas for combustion forward, a second nozzle provided at a position forward of the first nozzle in the rear ceiling portion and configured to discharge a

second gas for combustion from the rear ceiling portion toward the drying stage or the combustion stage, and a control unit configured to control an amount of the second gas for combustion discharged by the second nozzle based on a target air ratio in a primary combustion region that is a region in the furnace body.

[0007]

A combustion control method according to the present disclosure is a control method for a combustion facility, the combustion facility including a furnace into which gas after combustion flows, a furnace body including a drying stage, a combustion stage, and a post-combustion stage and configured to convey an object to be incinerated while combusting the object to be incinerated, the furnace body including, in a case where an upstream side in a conveyance direction of the object to be incinerated is referred to as front and a downstream side in the conveyance direction is referred to as rear, a front ceiling portion extending forward from the furnace, a rear ceiling portion extending rearward from the furnace, and a rear wall extending downward from a rear end portion of the rear ceiling portion, a first nozzle provided in a region of the rear ceiling portion rearward of a center of the rear ceiling portion in the conveyance direction or in the rear wall and configured to discharge a first gas for combustion forward, a second nozzle provided at a position forward of the first nozzle in the rear ceiling portion and configured to discharge a second gas for combustion from the rear ceiling portion toward the drying stage or the combustion stage, the control method including controlling, by one or more computers, an amount of the second gas for combustion discharged by the second nozzle based on a target air ratio in a primary combustion region that is a region in the furnace body.

Advantageous Effects of Invention

[0008]

According to the system for a combustion facility and the combustion control method of the present disclosure, it is possible to realize appropriate combustion.

BRIEF DESCRIPTION OF DRAWINGS

[0009]

[FIG. 1] FIG. 1 is a diagram showing an example of a configuration of a combustion facility according to a first embodiment of the present disclosure.

[FIG. 2] FIG. 2 is a diagram showing an example of a configuration of a storage unit according to the first embodiment of the present disclosure.

[FIG. 3] FIG. 3 is a diagram showing an example of the configuration of the combustion facility according to the first embodiment of the present disclosure.

[FIG. 4] FIG. 4 is a diagram showing an example of a gas flow in a combustion facility in which a second EGR nozzle is not present.

[FIG. 5] FIG. 5 is a diagram showing an example of a gas flow in the combustion facility in which the second EGR nozzle is present according to the first embodiment of the present disclosure.

[FIG. 6] FIG. 6 is a diagram showing an example of a relationship between an angle at which the second EGR nozzle discharges gas and combustion according to the first embodiment of the present disclosure.

[FIG. 7] FIG. 7 is a diagram showing an example of a relationship between a position at which the second EGR nozzle discharges gas and combustion according to the first embodiment of the present disclosure.

[FIG. 8] FIG. 8 is a diagram showing an example of a gas flow velocity in the combustion facility in which the second EGR nozzle is not present.

[FIG. 9] FIG. 9 is a diagram showing an example of a gas flow velocity in the combustion facility 1 in which the second EGR nozzle is present according to the first embodiment of the present disclosure.

[FIG. 10] FIG. 10 is a diagram showing an example of SRg in the combustion facility in which the second EGR nozzle is not present.

[FIG. 11] FIG. 11 is a diagram showing an example of SRg in the combustion facility 1 in which the second EGR nozzle is present according to the first embodiment of the present disclosure.

[FIG. 12] FIG. 12 is a diagram showing an example of a NOx concentration distribution in the combustion facility in which the second EGR nozzle is not present.

[FIG. 13] FIG. 13 is a diagram showing an example of a NOx concentration distribution in the combustion facility 1 in which the second EGR nozzle is present according to the first embodiment of the present disclosure.

[FIG. 14] FIG. 14 is a diagram showing an example of installation positions of a first EGR nozzle and the second EGR nozzle in the first embodiment of the present disclosure.

[FIG. 15] FIG. 15 is a diagram showing an example of a gas flow around the EGR nozzle in the first embodiment of the present disclosure.

[FIG. 16] FIG. 16 is a diagram showing a first example of a gas flow discharged by the first EGR nozzle by the gas discharged by the second EGR nozzle according to the first embodiment of the present disclosure.

[FIG. 17] FIG. 17 is a diagram showing a second example of the gas flow discharged by the first EGR nozzle by the gas discharged by the second EGR nozzle according to the first embodiment of the present disclosure.

[FIG. 18] FIG. 18 is a diagram showing an example of a relationship between

the gas flow discharged by the second EGR nozzle and the gas flow discharged by the first EGR nozzle according to the first embodiment of the present disclosure.

[FIG. 19] FIG. 19 is a diagram showing an example of a processing flow in which a combustion facility according to a second embodiment of the present disclosure controls EGR to be mixed in accordance with O_2.

[FIG. 20] FIG. 20 is a diagram showing an example of a processing flow in which the combustion facility according to the second embodiment of the present disclosure controls the EGR in accordance with O_2 and a speed of stoker.

[FIG. 21] FIG. 21 is a diagram showing an image of processing performed by a control unit 130 according to the second embodiment of the present disclosure.

[FIG. 22] FIG. 22 is a hardware configuration diagram showing a configuration of a computer according to the embodiment.

DESCRIPTION OF EMBODIMENTS

[0010]

Hereinafter, embodiments of the present disclosure will be described with reference to the drawings. In the following description, components having the same or similar functions are denoted by the same reference numerals. Duplicate descriptions of such components may be omitted. In the present disclosure, "based on XX" means "at least based on XX", and may include a case where one element exists based on another element in addition to XX. In addition, "based on XX" is not limited to a case where XX is directly used, and may also include a case where calculation or processing is performed on XX. In the present disclosure, "XX or YY" is not limited to a case of either XX or YY, and may also include a case of both XX and YY. The same applies to a case where the number of selective elements is three or more. "XX" and "YY" are

arbitrary elements (for example, arbitrary information).

[0011]

In the present application, "acquire" is not limited to a case where the information is actively acquired by transmitting a transmission request, and may also include a case where the information is acquired by passively receiving the information transmitted from another apparatus. In addition, a term "acquisition" is not limited to a case where target information (information to be acquired) is directly acquired from the outside, and may also include a case where the target information is generated and acquired by performing calculation or processing on the information obtained from the outside.

[0012]

In addition, in the embodiments described below, for the sake of convenience of description, a side where the furnace body 30 is located with respect to a hopper 21 to be described later is defined as "rear", and an opposite side is defined as "front". In the following, for convenience of description, an upstream side of an object to be incinerated in a conveyance direction may be referred to as a "front", and a downstream side of the object to be incinerated in the conveyance direction may be referred to as a "rear". In addition, the "front side" may be referred to as a "furnace front side", and the "rear side" may be referred to as a "furnace rear side". In addition, "left" and "right" are defined with reference to a direction from the hopper 21 toward the furnace body 30.

[0013]

(First Embodiment)

(Overall Configuration of Combustion Facility)

FIG. 1 is a diagram showing an example of a configuration of a combustion facility 1 according to a first embodiment of the present disclosure. For example, the

combustion facility 1 is a stoker furnace in which an object S to be incinerated is municipal waste, industrial waste, biomass, or the like. The combustion facility 1 is not limited to the stoker furnace and may be a combustion facility of another type. In the following description, for the sake of convenience of description, the "object to be incinerated" may be referred to as "waste". For example, the combustion facility 1 includes a storage unit 2 (refer to FIG. 2), an incinerator 3, a heat recovery steam generator 4, a temperature reduction tower 5, a dust collector 6, a flue 7, a chimney 8, and a control device 100.

[0014]

The storage unit 2 temporarily stores the collected object S to be incinerated. The incinerator 3 is a furnace that combusts the object S to be incinerated charged from the storage unit 2 while conveying the object S to be incinerated. The incinerator 3 generates exhaust gas as a result of combustion of the object S to be incinerated in the incinerator 3. The generated exhaust gas is fed to the heat recovery steam generator 4 provided in an upper portion of the incinerator 3. The heat recovery steam generator 4 heats water by exchanging heat between the exhaust gas generated in the incinerator 3 and the water, and generates steam. The exhaust gas passing through the heat recovery steam generator 4 is cooled at the temperature reduction tower 5, and thereafter, is fed to the dust collector 6. The exhaust gas is discharged to an atmosphere through the flue 7 and the chimney 8 after soot or dust is removed by the dust collector 6.

[0015]

(Storage Unit)

First, the storage unit 2 will be described in detail. FIG. 2 is a diagram showing an example of a configuration of the storage unit 2 according to the first embodiment of the present disclosure. The storage unit 2 is a facility that temporarily

stores the collected object S to be incinerated and charges the stored object S to be incinerated into the incinerator 3. For example, the storage unit 2 includes a waste pit 11, one or more cranes 12, and a camera 13.

[0016]

(Waste Pit)

The waste pit 11 is a housing part that is provided in front of the incinerator 3 and in which the object S to be incinerated before being charged into the incinerator 3 is temporarily stored.

[0017]

(Crane)

The crane 12 is provided on a ceiling of the storage unit 2. The crane 12 is driven based on a control instruction from a control unit 130 to be described later. For example, in a case where a new object S to be incinerated is brought into the waste pit 11 from a garbage truck, the brought-in object S to be incinerated is moved to the storage unit 2 based on the control instruction from the control unit 130.

[0018]

In addition, in a case where the crane 12 receives a control instruction to charge the object S to be incinerated stored in the waste pit 11 into the hopper 21 of the incinerator 3 from the control unit 130, the crane 12 moves to a region R that is a grasping destination of the object S to be incinerated in the waste pit 11, grasps the object S to be incinerated in the region R that is the grasping destination, and charges the grasped object S to be incinerated into the hopper 21.

[0019]

(Incinerator)

Next, the incinerator 3 will be described in detail with reference to FIG. 1. The

incinerator 3 includes, for example, a supply mechanism 20, a furnace body 30, a stoker 40, a discharge chute 43, a plurality of wind boxes 50, a furnace 60, a blowing mechanism 70, a first EGR nozzle 91 (an example of a first nozzle), and a second EGR nozzle 93 (an example of a second nozzle).

[0020]

(Supply Mechanism)

The supply mechanism 20 is a mechanism that temporarily stores the object S to be incinerated carried by the crane 12 and sequentially supplies the object S to be incinerated toward a treatment space V of the furnace body 30 to be described later. The supply mechanism 20 includes, for example, a hopper 21, a feeder 22, an extrusion device 23 (refer to FIG. 3), a moisture meter 24, and a water sprinkler device 25.

[0021]

(Hopper)

The hopper 21 is a storage unit provided to supply the object S to be incinerated into the furnace body 30. The hopper 21 includes an inlet portion for charging the object S to be incinerated and an outlet portion leading to the treatment space V of the furnace body 30 to be described later. The object S to be incinerated carried by the crane 12 is charged into the hopper 21.

[0022]

(Feeder)

The feeder 22 is provided at the bottom portion of the hopper 21. The feeder 22 is formed in, for example, a plate shape along the bottom portion of the hopper 21. The feeder 22 is driven by the extrusion device 23 and is capable of reciprocating along a direction from the hopper 21 toward the treatment space V of the furnace body 30. The feeder 22 is driven by the extrusion device 23 and extrudes the object S to be incinerated

accumulated in the hopper 21 toward the treatment space V of the furnace body 30.

[0023]

(Moisture Meter)

The moisture meter 24 is a measurement instrument that detects information on moisture content of the object S to be incinerated charged into the hopper 21 (for example, a moisture percentage or a moisture amount). For example, the moisture meter 24 includes an irradiation unit and a detection unit provided in the hopper 21, and an analysis unit. The irradiation unit irradiates the object S to be incinerated accumulated in the hopper 21 with electromagnetic waves in a predetermined frequency band. The detection unit receives the electromagnetic waves emitted from the irradiation unit and transmitted through the object S to be incinerated or reflected by the object S to be incinerated. For example, the analysis unit stores in advance correlation information indicating a relationship between a change in characteristics of the electromagnetic wave (for example, a change in amplitude or a change in phase) and the moisture content. The analysis unit detects the moisture percentage of the object S to be incinerated based on the change in the characteristics of electromagnetic waves between the irradiation unit and the detection unit, and the correlation information. The moisture meter 24 may detect the moisture amount of the object S to be incinerated based on the moisture percentage and the weight of the object S to be incinerated charged into the hopper 21.

[0024]

(Water Sprinkler Device)

The water sprinkler device 25 is a device that adjusts the moisture content of the object S to be incinerated by performing the water sprinkling on the object S to be incinerated. The water sprinkler device 25 is provided in the hopper 21, for example.

In a case where the moisture content of the object S to be incinerated is adjusted, the water sprinkler device 25 sprinkles water on the object S to be incinerated in the hopper 21 based on a control instruction from a control unit 130 to be described later.

[0025]

(Furnace Body)

The furnace body 30 is equipment that is provided adjacent to the hopper 21 and combusts the object S to be incinerated while conveying the object S to be incinerated. Hereinafter, a direction in which the object S to be incinerated is conveyed in the combustion facility 1 is referred to as a "conveyance direction D". The conveyance direction D may be referred to as a "depth direction".

[0026]

The furnace body 30 includes a drying stage 30a, a combustion stage 30b, and a post-combustion stage 30c in this order from an upstream side toward a downstream side in the conveyance direction D. The furnace body 30 conveys the object S to be incinerated from the upstream side to the downstream side while combusting the object S to be incinerated. The drying stage 30a is a region that is located upstream of the combustion stage 30b and the post-combustion stage 30c and in which the object S to be incinerated supplied from the hopper 21 is dried prior to combustion on the stoker 40. The combustion stage 30b and the post-combustion stage 30c are regions where the object S to be incinerated in a dried state that has passed through the drying stage 30a is combusted on the stoker 40. In the combustion stage 30b, diffusion combustion occurs due to a pyrolysis gas generated from the object S to be incinerated, and a flame F is generated. In the post-combustion stage 30c, fixed carbon combustion occurs after the diffusion combustion of the object S to be incinerated, and thus the flame F is not generated.

[0027]

(Furnace Temperature Sensor)

The furnace body 30 includes, for example, a furnace temperature sensor 31. The furnace temperature sensor 31 is, for example, a thermocouple, and detects the temperature inside the furnace body 30. In the present embodiment, only one furnace temperature sensor 31 is provided as a temperature sensor that detects the temperature inside the furnace body 30. The temperature inside the furnace body 30 is an example of the "temperature in the incinerator". The furnace temperature sensor 31 may be provided in the furnace 60 or at another location instead of or in addition to the furnace body 30. The temperature detected in the furnace 60 or at another location is another example of the "temperature in the incinerator".

[0028]

(Camera)

The furnace body 30 includes, for example, a visible light camera 32 and an infrared camera 33. The visible light camera 32 and the infrared camera 33 image the inside of the furnace body 30. For example, the visible light camera 32 and the infrared camera 33 are provided at an end portion on the downstream side of the furnace body 30 in the conveyance direction D (hereinafter, referred to as a "furnace rear end"), and image the upstream side in the conveyance direction D from the furnace rear end.

[0029]

The visible light camera 32 images the flame F, for example. The infrared camera 33 images, for example, the object S to be incinerated (waste layer) accumulated in the drying stage 30a of the furnace body 30 through the flame F. In addition, the infrared camera 33 may image the outlet portion of the hopper 21 instead of or in addition to the object S to be incinerated accumulated in the drying stage 30a. That is,

the infrared camera 33 may capture an image including the object S to be incinerated accumulated on the feeder 22 (image showing an accumulation state of the object S to be incinerated) at the outlet portion of the hopper 21. The imaging results of the visible light camera 32 and the infrared camera 33 are transmitted to the control device 100. The imaging result of the visible light camera 32 or the infrared camera 33 is an example of an "image obtained by imaging an inside of the incinerator".

[0030]

The infrared camera 33 may be configured by, for example, a plurality of infrared cameras disposed in a stereo manner. In addition, the visible light camera 32 and the infrared camera 33 may be provided at another position (the left side wall or the right side wall of the furnace body 30) instead of the furnace rear end of the furnace body 30. In addition, both or one of the visible light camera 32 and the infrared camera 33 may be omitted.

[0031]

(Stoker)

The stoker 40 includes a plurality of grate bars 41 and a grate bar drive device 42 (refer to FIG. 3). The plurality of grate bars 41 form a stoker surface 40a that serves as a bottom surface of the furnace body 30. The object S to be incinerated is supplied in a layered shape to the stoker surface 40a by the supply mechanism 20. The stoker surface 40a is provided over the drying stage 30a, the combustion stage 30b, and the post-combustion stage 30c described above. The plurality of grate bars 41 include a fixed grate bar and a movable grate bar. The fixed grate bar is fixed to an upper surface of the wind box 50 to be described later. The movable grate bar reciprocates along the conveyance direction D at a constant speed. In this manner, the object S to be incinerated on the movable grate bar and the fixed grate bar (on the stoker surface 40a) is

conveyed to the downstream side while the object S to be incinerated is stirred and mixed.

[0032]

(Discharge Chute)

The discharge chute 43 is a device that drops the object S to be incinerated completely combusted and turned into ash to an ash extrusion device located below the furnace body 30. The discharge chute 43 is provided at a furnace rear end of the furnace body 30. A wall on a rear side of the discharge chute 43 is a rear wall 59 to be described later.

[0033]

(Wind Boxes)

The plurality of wind boxes 50 are provided below the stoker 40 and supply primary air for combustion into the furnace body 30 through the stoker 40. The primary air is an example of "combustion air". In the present embodiment, the plurality of wind boxes 50 are disposed side by side in the conveyance direction D, for example, corresponding to the plurality of grate bars 41. Each wind box 50 is provided with a wind box pressure sensor 51 that detects a pressure in the wind box 50. The pressure in the wind box 50 corresponds to the pressure of the primary air supplied from the wind box 50 to the inside of the furnace body 30. The set of the detection result of each wind box pressure sensor 51 and/or the detection result of the plurality of wind box pressure sensors 51 is an example of "information on the supply of the combustion air".

[0034]

(Furnace)

The furnace 60 extends upward from an upper portion of the furnace body 30. The furnace 60 is disposed above the grate bar 41, and the gas after combustion flows

into the furnace 60. That is, the exhaust gas generated by the combustion of the object S to be incinerated in the furnace body 30 flows to the heat recovery steam generator 4 through the furnace 60. The furnace 60 includes a front wall 60a located on a front side of a space through which the exhaust gas flows, and a rear wall 60b located on a rear side of the space through which the exhaust gas flows. For example, the front wall 60a and the rear wall 60b each extend in the vertical direction. In a case where the upstream side in the conveyance direction of the object S to be incinerated is referred to as a front and the downstream side in the conveyance direction of the object S to be incinerated is referred to as a rear, the furnace 60 includes a front ceiling portion 55 extending forward from the furnace 60, a rear ceiling portion 57 extending rearward from the furnace 60, and a rear wall 59 extending downward from a rear end portion of the rear ceiling portion 57.

[0035]

(Blowing Mechanism)

The blowing mechanism 70 supplies combustion air into the furnace body 30 and the furnace 60. The blowing mechanism 70 includes, for example, a blower 71, a primary air line 72, an air preheater 73, a secondary air line 74, a damper 75, and an air flow rate sensor 76.

[0036]

The blower 71 is a pressure blower that pumps the combustion air into the furnace body 30 and the furnace 60. For example, the blower 71 includes a first blower 71A and a second blower 71B. The first blower 71A pumps the primary air for combustion into the furnace body 30 (for example, the treatment space V) through the primary air line 72 and the plurality of wind boxes 50. The second blower 71B pumps the secondary air for combustion into the furnace 60 through the secondary air line 74.

The secondary air is another example of the “combustion air”.

[0037]

The primary air line 72 connects the first blower 71A and the plurality of wind boxes 50 to each other. One or more (for example, a plurality of) primary air dampers 75A are provided in the middle of the primary air line 72. In the present embodiment, the plurality of primary air dampers 75A are provided to correspond to the plurality of wind boxes 50 on a one-to-one basis. The primary air damper 75A changes a flow rate of the primary air flowing from the primary air line 72 into the wind box 50 corresponding to the primary air damper 75A, depending on an opening degree of the primary air damper 75A. In other words, the distribution amount of the primary air in the plurality of wind boxes 50 (which wind box 50 is preferentially supplied with the primary air into the furnace body 30) is changed by the opening degree of the plurality of primary air dampers 75A. The set of the opening degree of each primary air damper 75A and/or the opening degree of the plurality of primary air dampers 75A is another example of the “information on the supply of the combustion air”.

[0038]

The air preheater 73 is a heat exchanger that preheats the primary air pumped from the first blower 71A. For example, the air preheater 73 is provided in the middle of the primary air line 72. The air preheater 73 includes a preheat temperature sensor 73a that detects the temperature of the preheated primary air. The detection result of the preheat temperature sensor 73a is another example of the “information on the temperature of the combustion air”.

[0039]

The secondary air line 74 connects the second blower 71B and the furnace 60. In the present embodiment, the secondary air line 74 includes a first supply port 74a and

a second supply port 74b. The first supply port 74a is open to the front wall 60a of the furnace 60, and supplies the secondary air from the front wall 60a of the furnace 60 to a space (exhaust gas flow path) in the furnace 60. On the other hand, the second supply port 74b is open to the rear wall 60b of the furnace 60, and supplies the secondary air from the rear wall 60b of the furnace 60 to a space (exhaust gas flow path) in the furnace 60.

[0040]

One or more (for example, a plurality of) secondary air dampers 75B are provided in the middle of the secondary air line 74. In the present embodiment, the plurality of secondary air dampers 75B are provided to correspond to the plurality of supply ports (for example, the supply ports 74a and 74b) provided in the furnace 60 in a one-to-one manner. The distribution amount of the secondary air in the plurality of supply ports (for example, the supply ports 74a and 74b) (which supply port is preferentially supplied with the secondary air into the furnace 60) is changed by the opening degree of the secondary air damper 75B. The set of the opening degree of each secondary air damper 75B and/or the opening degree of the plurality of secondary air dampers 75B is another example of the "information on the supply of the combustion air". In the following description, for the sake of convenience of description, the primary air damper 75A and the secondary air damper 75B will be collectively referred to as a "damper 75".

[0041]

The air flow rate sensor 76 detects the flow rate of the combustion air supplied to the inside of the furnace body 30 and the furnace 60. The air flow rate sensor 76 includes, for example, a first air flow rate sensor 76A and a second air flow rate sensor 76B. The first air flow rate sensor 76A is provided in an intermediate portion of the

primary air line 72 and detects the flow rate of the primary air supplied through the primary air line 72. The second air flow rate sensor 76B is provided in an intermediate portion of the secondary air line 74 and detects the flow rate of the secondary air supplied through the secondary air line 74. The detection result of each of the first air flow rate sensor 76A and the second air flow rate sensor 76B is another example of the "information on the supply of the combustion air".

[0042]

(Gas Sensor)

Next, a gas sensor 81 will be described. The gas sensor 81 is a sensor that detects components in the exhaust gas. The gas sensor 81 can detect, for example, an oxygen concentration (hereinafter, referred to as an "O_2 concentration"), a carbon monoxide concentration (hereinafter, referred to as a "CO concentration") (unburned content), a carbon dioxide concentration (hereinafter, referred to as a "CO_2 concentration"), or a NOx concentration contained in the exhaust gas, an air ratio in the primary combustion region, and the like. The gas sensor 81 is provided in, for example, the flue gas duct 7, but may be provided inside the stack 8 or may be provided at another place (for example, a place where the gas after combustion can be detected). The detection result of the gas sensor 81 is an example of "information on the components in the exhaust gas".

[0043]

The first EGR nozzle 91 is provided in a region of the rear ceiling portion 57 rearward of the center of the rear ceiling portion 57 in the conveyance direction of the material S to be incinerated, or in the rear wall 59 extending downward from the rear end portion of the rear ceiling portion 57. The first EGR nozzle 91 discharges EGR (an example of a first gas for combustion), air, or EGR (an example of the first gas for

combustion) mixed with air forward.

[0044]

In a case where the first EGR nozzle 91 is provided in the rear wall 59 extending downward from the rear end portion of the rear ceiling portion 57, the first EGR nozzle 91 may discharge EGR (an example of the first gas for combustion), air, or EGR (an example of the first gas for combustion) mixed with air in an orientation in which a wall jet along the rear ceiling portion 57 is formed. For example, a horizontal distance between a rear end and a front end of the rear ceiling portion 57 is defined as "X", a vertical distance between the front end and a center of an opening of the first EGR nozzle 91 is defined as "H", an angle formed by the rear ceiling portion 57 and a horizontal plane is defined as "α", and an angle formed by a center line O of the first EGR nozzle 91 and the horizontal plane is defined as "β". In this case, the second EGR nozzle 93 may be disposed at the furnace rear end to satisfy the following Expression (I).

[0045]

$$\mathrm{atan}\left((H/X)+\tan(\alpha)\right)-\beta<10\cdots(I)$$

[0046]

The horizontal distance referred to herein means a two-dimensional geometric distance in a horizontal direction. In addition, the vertical distance means a one-dimensional geometric distance in the vertical direction. In addition, "atan((H/X) + tan(α)) - β" on the left-hand side of Expression (I) is larger than 0. The gas discharged by the first EGR nozzle 91 is formed into a wall jet, and thus is easily mixed.

[0047]

The second EGR nozzle 93 is provided at a position forward of the first EGR nozzle 91 in the rear ceiling portion 57. The second EGR nozzle 93 discharges EGR

(an example of a second gas for combustion), air, or EGR (an example of the second gas for combustion) mixed with air from the rear ceiling portion 57 toward the drying stage 30a or the combustion stage 30b. The second EGR nozzle 93 includes an angle adjustment mechanism 97 capable of changing an orientation in which EGR (an example of the second gas for combustion), air, or EGR (an example of the second gas for combustion) mixed with air is discharged. Examples of the angle adjustment mechanism 97 include a tilt mechanism.

[0048]

For example, the second EGR nozzle 93 is provided in a region forward of a center of the rear ceiling portion 57 in the conveyance direction of the object S to be incinerated in the rear ceiling portion 57. More specifically, for example, in a case where the rear ceiling portion 57 is virtually divided into four regions in the conveyance direction of the object S to be incinerated, the second EGR nozzle 93 is provided in a frontmost region among the four divided regions. The reason why the second EGR nozzle 93 is provided at such a position will be described later.

[0049]

In addition, for example, in a case where a forward direction in a horizontal direction is defined as 0°, the second EGR nozzle 93 discharges EGR (an example of the second gas for combustion), air, or EGR (an example of the second gas for combustion) mixed with air in a direction included in an angular range of 60° or more and 90° or less with respect to the horizontal direction. The reason why the second EGR nozzle 93 discharges the gas at such an angle will be described later.

[0050]

Here, the advantages of the combustion facility 1 in which the second EGR nozzle 93 is present over the combustion facility in which the second EGR nozzle 93 is

not present will be described. FIG. 4 is a diagram showing an example of a gas flow in the combustion facility in which the second EGR nozzle 93 is not present. FIG. 5 is a diagram showing an example of a gas flow in the combustion facility 1 in which the second EGR nozzle 93 is present according to the first embodiment of the present disclosure.

[0051]

A broken line A shown in FIG. 4 shows an example of a flow of the EGR (an example of the first gas for combustion), the air, or the EGR (an example of the first gas for combustion) mixed with the air, which is discharged by the first EGR nozzle 91. In addition, a broken line B shown in FIG. 4 shows an example of a gas flow of the volatile matter of combustion by the primary air charged from below the combustion stage 30b. In this case, the gas discharged by the first EGR nozzle 91 is not sufficiently mixed with the gas of the volatile matter, and as shown in FIG. 4, in a case of the combustion facility in which the second EGR nozzle 93 is not present, both the gas discharged by the first EGR nozzle 91 and the gas of the volatile matter of combustion by the primary air flow toward the furnace 60 along the space in the furnace body 30.

[0052]

A broken line A' shown in FIG. 5 shows an example of a flow of the EGR (an example of the first gas for combustion), the air, or the EGR (an example of the first gas for combustion) mixed with the air, which is discharged by the first EGR nozzle 91. In addition, a broken line B' shown in FIG. 5 shows an example of a gas flow of the volatile matter of combustion by the primary air charged from below the combustion stage 30b. A broken line C shown in FIG. 5 shows an example of a flow of the EGR (an example of the second gas for combustion), the air, or the EGR (an example of the second gas for combustion) mixed with the air, which is discharged by the second EGR nozzle 93. A

broken line D shown in FIG. 5 shows an example of a flow of the dried air charged from below the drying stage 30a. As shown in FIG. 5, the gas flow A of the gas discharged by the first EGR nozzle 91 is pushed downward by the gas flow C of the gas discharged by the second EGR nozzle 93 and is changed to the gas flow A' shown in FIG. 4. The gas flow B shown in FIG. 4 is pushed downward by the gas flow A' shown in FIG. 5 and is changed to the gas flow B' shown in FIG. 5. That is, in a case where the second EGR nozzle 93 discharges the EGR (an example of the second gas for combustion), the air, or the EGR (an example of the second gas for combustion) mixed with the air in a direction included in an angular range of 60° or more and 90° or less with respect to the horizontal direction in a case where the forward direction in the horizontal direction is defined as 0°, the gas of the volatile matter of combustion by the primary air is pushed downward, and a retention time in the furnace body 30 is increased. As a result, the mixing of the gas of the volatile matter of combustion by the primary air and the gas discharged by the first EGR nozzle 91 or the second EGR nozzle 93 is further promoted. That is, the combustion of the object S to be incinerated is promoted. In addition, the flow of the dry air D to the furnace rear side is suppressed by the gas of the flow A' or the flow B' or the gas C. As a result, the amount of the air with respect to the gas of the volatile matter can be controlled by the gas discharged by the first EGR nozzle 91 or the second EGR nozzle 93 and the air charged from below the drying stage 30a, the combustion stage 30b, and the post-combustion stage 30c. That is, the combustion of the object S to be incinerated in the combustion stage 30b can be controlled.

[0053]

FIG. 6 is a diagram showing an example of a relationship between an angle at which the second EGR nozzle 93 discharges a gas and combustion according to the first embodiment of the present disclosure. The horizontal axis in FIG. 6 indicates the angle

at which the second EGR nozzle 93 discharges a gas in a case where the front in the horizontal direction is defined as 0°. In addition, the left vertical axis in FIG. 6 indicates a NOx concentration. In addition, the right vertical axis in FIG. 6 indicates a CO concentration. The CO concentration on the right vertical axis is a relative value in a case where the CO concentration in a case where the second EGR nozzle 93 does not discharge a gas is set to 1. From FIG. 6, it can be seen that the NOx concentration is reduced in a case where the angle at which the second EGR nozzle 93 discharges a gas is 60° or more and 90° or less. The NOx concentration and the CO concentration are in a trade-off relationship. Therefore, in practice, an appropriate concentration is determined by the balance between the NOx concentration and the CO concentration.

[0054]

FIG. 7 is a diagram showing an example of a relationship between a position at which the second EGR nozzle 93 discharges a gas and combustion according to the first embodiment of the present disclosure. The horizontal axis in FIG. 7 indicates the position at which the second EGR nozzle 93 discharges a gas in a case where the position of the foremost end of the drying stage 30a is set to 0 and the position of the rearmost end of the drying stage 30a is set to 1. In addition, the left vertical axis in FIG. 7 indicates the NOx concentration. In addition, the right vertical axis in FIG. 7 indicates the CO concentration. The CO concentration on the right vertical axis is a relative value in a case where the CO concentration in a case where the second EGR nozzle 93 does not discharge a gas is set to 1. From FIG. 7, it can be seen that the NOx concentration is the lowest in a case where the position at which the second EGR nozzle 93 discharges a gas is in a range of 0 to about 0.25 (that is, in a case where the second EGR nozzle 93 discharges gas in the frontmost region among four regions obtained by virtually dividing the rear ceiling portion 57 into four regions in the conveyance direction of the object S to

be incinerated). In addition, from FIG. 7, it can be seen that the NOx concentration starts to significantly increase in a case where the position at which the second EGR nozzle 93 discharges a gas is a position of about 0.25 (that is, in a case where the position at which the second EGR nozzle 93 discharges a gas in the rear ceiling portion 57 exceeds about 0.25). Therefore, it is desirable that the second EGR nozzle 93 is provided in a region within 1/2 of the front side of the rear ceiling portion 57 (in a region within 1/4 if possible). This is to increase the residence time in the furnace rear space in which an ideal air ratio distribution for NOx reduction is achieved. In addition, this is because the second EGR nozzle 93 provided in the vicinity of the front end portion of the rear ceiling portion 57 pushes the volatile matter to the furnace rear end and pushes the air on the furnace front side to the secondary combustion region, thereby obtaining an effect of promoting the formation of the assumed air ratio distribution in the furnace rear space (an effect of preventing the furnace rear end air ratio from being determined by circumstances). Further, in order to form an ideal air ratio distribution for NOx reduction in the furnace rear space, it is necessary to set an air ratio target for the gas charged from each of the first EGR nozzle 91 and the second EGR nozzle 93 and to individually control the gas flow rate.

[0055]

FIG. 8 is a diagram showing an example of a gas flow velocity in the combustion facility in which the second EGR nozzle 93 is not present. FIG. 9 is a diagram showing an example of a gas flow velocity in the combustion facility 1 in which the second EGR nozzle 93 is present according to the first embodiment of the present disclosure. In FIGS. 8 and 9, the thickness of an arrow indicates the flow velocity. In addition, in FIGS. 8 and 9, the orientation of the arrow indicates the orientation of the gas flow. In addition, a portion A shown in FIG. 9 indicates a region that is positioned

between the drying stage 30a and the furnace rear end and in which the flow velocity is substantially 0. It can be seen that, in the combustion facility 1 in which the second EGR nozzle 93 is present, the dry air does not flow to the furnace rear side due to the region A. Meanwhile, in the combustion facility in which the second EGR nozzle 93 is not present as shown in FIG. 8, the region A as shown in FIG. 9 is not present. That is, in the combustion facility in which the second EGR nozzle 93 is not present, the dry air flows to the furnace rear side.

[0056]

FIG. 10 is a diagram showing an example of SRg in the combustion facility in which the second EGR nozzle 93 is not present. FIG. 9 is a diagram showing an example of SRg in the combustion facility 1 in which the second EGR nozzle 93 is present according to the first embodiment of the present disclosure. In FIGS. 8 and 9, the portion A indicates a region in which SRg is substantially 1. In addition, in FIGS. 8 and 9, a portion B indicates a region in which SRg is larger than that in the region A. In addition, in FIGS. 8 and 9, a portion C indicates a region in which SRg is lower than that in the region A. SRg represents a local air ratio, and as SRg is closer to 1, the EGR and the air are more satisfactorily mixed. It can be seen that, in FIG. 9, the region A is expanded in the combustion stage 30b and the post-combustion stage 30c, that is, the EGR and the air are satisfactorily mixed, as compared with FIG. 8.

[0057]

FIG. 12 is a diagram showing an example of a NOx concentration distribution in the combustion facility in which the second EGR nozzle 93 is not present. FIG. 13 is a diagram showing an example of a NOx concentration distribution in the combustion facility 1 in which the second EGR nozzle 93 is present according to the first embodiment of the present disclosure. In FIGS. 12 and 13, the NOx concentration

gradually increases in the order of the portion A, the portion B, the portion C, and the portion D. It can be seen that, in FIG. 13, the portion A having a low NOx concentration is expanded by the region in which the air ratio is substantially 1 as shown in FIG. 9, as compared with FIG. 12.

[0058]

FIG. 14 is a diagram showing an example of installation positions of the first EGR nozzle 91 and the second EGR nozzle 93 in the first embodiment of the present disclosure. FIG. 14 is a bird's-eye view of the combustion facility 1 as viewed from above. A plurality of first EGR nozzles 91 may be provided. In this case, the plurality of first EGR nozzles 91 include the first EGR nozzle 91 according to the first embodiment of the present disclosure and are provided in a region of the rear ceiling portion 57 rearward of the center of the rear ceiling portion 57 in the conveyance direction of the object S to be incinerated, or in the rear wall 59 extending downward from the rear end portion of the rear ceiling portion 57. The plurality of first EGR nozzles 91 discharge EGR (an example of the first gas for combustion), air, or EGR (an example of the first gas for combustion) mixed with air forward. In addition, a plurality of virtual lines extending forward from the plurality of first EGR nozzles 91 are defined, and the second EGR nozzle 93 is disposed between the plurality of virtual lines as viewed from above. In this case, the bending of the gas discharged by the second EGR nozzle 93 shown in FIG. 18 to be described later is reduced. In this case, the mixing of the gas may be promoted by installing the first EGR nozzle 91 to satisfy Expression (I) described above.

[0059]

As shown in FIG. 14, in a case where the plurality of first EGR nozzles 91 and the plurality of second EGR nozzles 93 are provided, it is desirable that the plurality of

virtual lines extending forward from the plurality of first EGR nozzles 91 are defined, and the second EGR nozzles 93 are disposed between the plurality of virtual lines. Accordingly, it is possible to suppress the interference between the gas discharged by the first EGR nozzle 91 and the gas discharged by the second EGR nozzle 93. That is, it is possible to easily control the orientation of the gas discharged by each of the first EGR nozzle 91 and the second EGR nozzle 93.

[0060]

FIG. 15 is a diagram showing an example of a gas flow around the EGR nozzle in the first embodiment of the present disclosure. The EGR nozzles in this case are the first EGR nozzle 91 and the second EGR nozzle 93. As shown in FIG. 15, it is known that the gas around the first EGR nozzle 91 and the second EGR nozzle 93 is sucked into the nozzles. In the embodiment of the present disclosure, the second EGR nozzle 93 is provided at the front end of the rear ceiling portion 57 by using this feature, so that the unburned gas is prevented from flowing to the secondary combustion region (that is, the furnace 60).

[0061]

FIG. 16 is a diagram showing a first example of a gas flow discharged by the first EGR nozzle 91 by the gas discharged by the second EGR nozzle 93 according to the first embodiment of the present disclosure. FIG. 17 is a diagram showing a second example of the gas flow discharged by the first EGR nozzle 91 by the gas discharged by the second EGR nozzle 93 according to the first embodiment of the present disclosure. In the example shown in FIG. 16, the amount of the gas discharged by the second EGR nozzle 93 is larger than that in the example shown in FIG. 17. In a case where the amount of the gas discharged by the second EGR nozzle 93 is too large, the ash present in the combustion stage 30b, the post-combustion stage 30c, or the like is scattered, and

as a result, unnecessary ash may be mixed with the gas. In addition, in a case where the amount of the gas discharged by the second EGR nozzle 93 is too small, the gas of the volatile matter of combustion by the primary air described above is pushed downward, the retention time in the furnace body 30 is shortened, and the effect of the gas discharged by the second EGR nozzle 93 is reduced. That is, it is desirable that the second EGR nozzle 93 discharges the gas such that the gas of the volatile matter of combustion by the primary air can be pushed downward as much as possible within a range in which the ash is not scattered.

[0062]

FIG. 18 is a diagram showing an example of a relationship between the gas flow discharged by the second EGR nozzle 93 and the gas flow discharged by the first EGR nozzle 91 according to the first embodiment of the present disclosure. In FIG. 18, a flow velocity U0 is a flow velocity of the gas discharged by the second EGR nozzle 93, and a flow velocity U1 is a flow velocity of the gas discharged by the first EGR nozzle 91. As shown in FIG. 18, it can be seen that the gas flow discharged by the second EGR nozzle 93 is determined by a relationship between the flow velocity U0 and the flow velocity U1. That is, it can be seen that, in order for the second EGR nozzle 93 to discharge the gas such that the gas of the volatile matter of combustion by the primary air can be pushed downward as much as possible within a range in which the ash is not scattered, the flow velocity U0 and the flow velocity U1 also need to be considered.

[0063]

(Control Device)

Next, the control device 100 will be described. FIG. 4 is a block diagram showing a functional configuration of the combustion facility 1. The control device 100 comprehensively controls the combustion facility 1. For example, the control device

100 performs combustion control of the object S to be incinerated in the furnace body 30. In the present disclosure, "combustion control" means broadly control related to combustion of the object S to be incinerated, and means controlling one or more of, for example, the supply amount of the object S to be incinerated, the moisture content of the object S to be incinerated, a conveyance speed of the object S to be incinerated, the flow rate and/or the distribution amount of primary air, the temperature of the primary air, the flow rate and/or the distribution amount of secondary air, and the like.

[0064]

In the present embodiment, the control device 100 includes, for example, an information acquisition unit 110 and a control unit 130. A device to be controlled by the control unit 130 (hereinafter, referred to as a "device VD to be controlled") includes the crane 12, the extrusion device 23, the water sprinkler device 25, the grate bar drive device 42, the blower 71, the air preheater 73, the damper 75, the first EGR nozzle 91, the second EGR nozzle 93, and the like.

[0065]

(Information Acquisition Unit)

The information acquisition unit 110 acquires a detection result detected by various sensors provided in the combustion facility 1. For example, the information acquisition unit 110 acquires a detection result of the camera 13 provided in the storage unit 2, a detection result of the moisture meter 24 (information on the moisture content of the object S to be incinerated), a detection result of the furnace temperature sensor 31 (information on the temperature in the incinerator 3), an imaging result of the visible light camera 32 (information on a combustion flame viewed from the furnace rear end), an imaging result of the infrared camera 33 (information on the waste layer), a detection result of each wind box pressure sensor 51 (information on the flow rate and/or the

distribution amount of the primary air), a detection result of the preheat temperature sensor 73a (information on the temperature of the primary air (the temperature of the combustion air)), a detection result of the air flow rate sensor 76 (information on the flow rate of the combustion air), and a detection result of the gas sensor 81 (information on the components in the exhaust gas). Hereinafter, these are collectively referred to as "various types of detection information".

[0066]

In addition, the information acquisition unit 110 acquires control information indicating the state of each device included in the device VD to be controlled from each device or the control unit 130. For example, the information acquisition unit 110 acquires control information indicating a gripping destination of the crane 12 in the waste pit 11, control information indicating a driving state of the feeder 22 by the extrusion device 23 (information on the supply amount of the object S to be incinerated, for example, a moving speed and/or a stroke length of the feeder 22), control information indicating a driving state of the grate bar drive device 42 (information on the conveyance speed of the object S to be incinerated), control information indicating a driving amount of the blower 71 (information on the supply of the combustion air), control information indicating a heating amount of the air preheater 73 (information on the supply of the primary air), and control information indicating an opening degree of the damper 75 (information on the supply of the combustion air). Hereinafter, these are collectively referred to as "various types of control information".

[0067]

(Control Unit)

The control unit 130 controls the flow velocity of the gas discharged by the first EGR nozzle 91 and the second EGR nozzle 93 to a desired flow velocity. The flow rate

of the gas is also controlled by controlling the flow velocity of the gas. In addition, the control unit 130 controls the discharge direction of the gas of the second EGR nozzle 93, for example, by controlling the orientation of the angle adjustment mechanism 97 in accordance with the component contained in the gas detected by the gas sensor 81. For example, in a case where the CO concentration is suppressed, the control unit 130 performs control to bring the discharge direction of the gas close to 60° in a range of 60° to 90° by adjusting the orientation of the angle adjustment mechanism 97. In addition, for example, in a case where the NOx concentration is suppressed, the control unit 130 performs control to bring the discharge direction of the gas close to 90° in a range of 60° to 90° by adjusting the orientation of the angle adjustment mechanism 97. The control by the control unit 130 is control in which the combustion facility 1 in which the second EGR nozzle 93 is present is superior to the combustion facility in which the second EGR nozzle 93 is not present. That is, the second EGR nozzle 93 is disposed to obtain the effects described with reference to FIGS. 14 and 15, and the control unit 130 performs control to obtain the effects described with reference to FIGS. 9, 11, 13, 16, 17, and 18. The flow velocity of the gas discharged by the first EGR nozzle 91 and the second EGR nozzle 93 may be changed by changing the nozzle diameter.

[0068]

In addition, the control unit 130 performs combustion control on the incinerator 3 based on the value related to the position or the shape of the flame F derived by the flame information derivation unit 120. For example, the control unit 130 performs control of one or more of the supply amount of the object S to be incinerated, the moisture content of the object S to be incinerated, the conveyance speed of the object S to be incinerated, the supply amount and/or the distribution amount of the primary air, the temperature of the combustion air (for example, the temperature of the primary air), and

the supply amount and/or the distribution amount of the secondary air, based on one or more of the center of gravity position G of the flame F, the burnout position PE of the flame F, and the width W of the flame F in the depth direction.

[0069]

In addition, the control unit 130 changes the supply amount of the object S to be incinerated by controlling the extrusion apparatus 23 to change the moving speed or the stroke length of the feeder 22. The control unit 130 changes the moisture content of the object S to be incinerated by performing the water sprinkling by the water sprinkler device 25. The control unit 130 changes the conveyance speed of the object S to be incinerated by controlling the grate bar drive device 42 to change the drive speed of the grate bar 41. The control unit 130 changesthe flow rate of the primary air and/or the flow rate of the secondary air by controlling the blower 71. The control unit 130 changes the temperature of the primary air by performing heating by the air preheater 73. The control unit 130 controls the distribution amount of the primary air and/or the distribution amount of the secondary air by controlling the opening degree of the damper 75.

[0070]

In addition, the control unit 130 performs combustion control on the incinerator 3 based on the center of gravity position G of the flame F derived by the flame information derivation unit 120. For example, in a case where the center of gravity position G of the flame F derived by the flame information derivation unit 120 is different from a planned position (center of gravity planned position), the control unit 130 controls one or more of the supply amount of the object S to be incinerated, the moisture content of the object S to be incinerated, the conveyance speed of the object S to be incinerated, the flow rate and/or the distribution amount of the primary air, and the

temperature of the combustion air (for example, the temperature of the primary air) such that the center of gravity position G of the flame F approaches the planned position.

[0071]

For example, in a case where the center of gravity position G of the flame F is on the furnace rear side with respect to the planned position, the control unit 130 performs one or more of reducing the supply amount of the object S to be incinerated (for example, reducing the moving speed of the feeder 22 or shortening the stroke length), maintaining the low moisture content of the object S to be incinerated (for example, suppressing the water sprinkling by the water sprinkler device 25), reducing the conveyance speed of the object S to be incinerated (for example, reducing the drive speed of the grate bar 41), increasing the supply amount of the primary air (for example, increasing the drive amount of the first blower 71A), increasing the distribution amount of the primary air with respect to the position on the furnace front side (for example, increasing the opening degree of the primary air damper 75A corresponding to one or more wind boxes 50 located on the furnace front side), and increasing the preheating temperature by the air preheater 73, so that drying of the object S to be incinerated proceeds on the upstream side. On the other hand, in a case where the center of gravity position G of the flame F is on the furnace front side with respect to the planned position, the control unit 130 performs control opposite to the above-described content.

[0072]

The combustion facility 1 according to the first embodiment of the present disclosure has been described above. The combustion facility 1 includes the furnace 60 into which gas after combustion flows, the furnace body 30 that includes the drying stage 30a, the combustion stage 30b, and the post-combustion stage 30c and that conveys the object S to be incinerated while combusting the object S to be incinerated, the furnace

body 30 including, in a case where the upstream side in the conveyance direction of the object S to be incinerated is referred to as front and the downstream side in the conveyance direction of the object S to be incinerated is referred to as rear, the front ceiling portion 55 extending forward from the furnace 60, the rear ceiling portion 57 extending rearward from the furnace 60, and the rear wall 59 extending downward from the rear end portion of the rear ceiling portion 57, the first EGR nozzle 91 (an example of the first nozzle) that is provided in a region of the rear ceiling portion 57 rearward of the center of the rear ceiling portion 57 in the conveyance direction or in the rear wall 59, and that discharges the first gas for combustion forward, the second EGR nozzle 93 (an example of the second nozzle) that is provided at a position forward of the first EGR nozzle 91 in the rear ceiling portion 57 and that discharges the second gas for combustion from the rear ceiling portion 57 toward the drying stage 30a or the combustion stage 30b, and the control unit 130 that controls the amount of the second gas for combustion discharged by the second EGR nozzle 93 based on the target air ratio in the primary combustion region, which is a region in the furnace body 30.

[0073]

The combustion facility 1 can realize the stabilization of the exhaust gas components (for example, reduction of NOx). That is, the combustion facility 1 can realize appropriate combustion.

[0074]

The above-described process performed by the combustion facility 1 is an example, and the process performed by the combustion facility 1 is not limited to the above-described process. For example, the combustion facility 1 may perform a process to be described below.

[0075]

(Second Embodiment)

Next, the combustion facility 1 according to a second embodiment of the present disclosure will be described. The combustion facility 1 according to the second embodiment further includes a detection unit 95 that detects a decrease in O_2 concentration inside the furnace body 30 (for example, the processing space V, which is an example of the primary combustion region) in addition to the configuration of the combustion facility 1 according to the first embodiment. In a case where the detection unit 95 detects the decrease in O_2 concentration inside the furnace body 30, the control unit 130 according to the second embodiment performs control to increase the O_2 concentration of the EGR (an example of the first gas for combustion), the air, or the EGR (an example of the first gas for combustion) mixed with the air, which is discharged by the first EGR nozzle 91. In a case where an increase in O_2 concentration of the EGR (an example of the first gas for combustion), the air, or the EGR (an example of the first gas for combustion) mixed with the air, which is discharged by the first EGR nozzle 91, or a sign of the increase is not detected even after the control to increase the O_2 concentration is performed, the control unit 130 according to the second embodiment performs control to increase the O_2 concentration of the EGR (an example of the second gas for combustion), the air, or the EGR (an example of the second gas for combustion) mixed with the air, which is discharged by the second EGR nozzle 93.

[0076]

The detection unit 95 may detect a state inside the furnace body 30 (for example, burnout of the solid fuel layer or a combustion flame) in any manner. For example, the detection unit 95 may detect the decrease in O_2 concentration inside the furnace body 30 based on an exhaust gas concentration prediction model created by a prediction model creation device described in Japanese Patent No. 7085039.

[0077]

For example, the prediction model creation device is a device that creates the exhaust gas concentration prediction model that predicts the concentration of a gas component contained in the exhaust gas discharged by the furnace body 30. The prediction model creation device includes an image acquisition unit, an extracting unit, an exhaust gas concentration acquisition unit, and a model creation unit. The image acquisition unit acquires an image in which the combustion region of the furnace body 30 is imaged. The extracting unit converts the image into color image data in which the image is divided into a plurality of color regions in accordance with RGB values by a clustering process, and extracts a total pixel count of at least one color region having a correlation equal to or higher than a predetermined value with the concentration of the gas component among the plurality of color regions as a feature quantity. The exhaust gas concentration acquisition unit acquires the concentration of the gas component contained in the exhaust gas after a set time set in advance has elapsed from a time when the image is captured, in a downstream side of the combustion region. The model creation unit creates the exhaust gas concentration prediction model by performing machine learning on training data in which the feature quantity extracted by the extracting unit and the concentration of the gas component acquired by the exhaust gas concentration acquisition unit are associated with each other.

[0078]

The EGR gas is charged from the furnace rear end and combusted to achieve reduction of NOx, but there is a problem in that the burnout point retreats. In order to solve this problem, it is necessary to improve the O_2 concentration, which can be achieved by mixing the air with the EGR. In addition, since the position of the burnout point changes depending on the O_2 concentration, there is an optimum point. Therefore,

in order to set the combustion completeness to arbitrary value, the O_2 concentration of the gas charged from the furnace rear end is controlled to a desired concentration by mixing the air with the EGR. This can be achieved by increasing the temperature of the combustion gas in the furnace body 30 by increasing the O_2 concentration.

[0079]

In addition, the reduction of NOx is achieved by mixing the EGR with the combustion air and combusting the mixture, but the CO increases as a trade-off. In order to control the CO and the NOx at the optimum point, it is necessary to control the amount of the EGR to be mixed with the combustion air (OFA). Whether or not the CO remains in the secondary combustion region is closely related to the CO in the primary combustion region. Therefore, the degree to which the EGR is mixed in the secondary combustion region is determined by monitoring the combustion in the primary combustion region.

[0080]

The above-described process performed by the combustion facility 1 is an example, and the process performed by the combustion facility 1 is not limited to the above-described process. For example, the combustion facility 1 may perform a process to be described below.

[0081]

(Process Performed by Combustion Facility)

Here, it is assumed that the detection unit 95 predicts at least one of the O_2 concentration, the NOx concentration, the CO concentration, the CO_2 concentration, and the air ratio in the primary combustion region in the furnace body 30 by the exhaust gas concentration prediction model created by the above-described prediction model creation device. FIG. 19 is a diagram showing an example of a processing flow in which the

combustion facility 1 according to the second embodiment of the present disclosure controls the EGR to be mixed in accordance with at least one of O_2, NOx, CO, CO_2, and the primary combustion region. In addition, FIG. 20 is a diagram showing an example of a processing flow in which the combustion facility 1 according to the second embodiment of the present disclosure controls the EGR in accordance with at least one of O_2, NOx, CO, CO_2, and the primary combustion region and the stoker speed.

[0082]

First, a process performed by the combustion facility 1 shown in FIG. 19 will be described. The detection unit 95 detects at least one of a decrease in O_2, a decrease in NOx, an increase in CO, an increase in CO_2, and a decrease in the air ratio in the primary combustion region (Step S1). The control unit 130 mixes the air with the EGR discharged by the first EGR nozzle 91 to increase the O_2 concentration, to increase the NOx concentration, to decrease the CO concentration, to decrease the CO_2 concentration, or to increase the air ratio in the primary combustion region in accordance with the detection (Step S2). The detection unit 95 detects whether or not there is a sign of an increase in O_2, whether or not there is a sign of an increase in NOx, whether or not there is a sign of a decrease in CO, whether or not there is a sign of a decrease in CO_2, or whether or not there is a sign of an increase in the air ratio in the primary combustion region in accordance with the detection (Step S3).

[0083]

In a case where the detection unit 95 does not detect the sign in accordance with the detection (NO in Step S3), the process returns to Step S2. In addition, in a case where the detection unit 95 detects the sign in accordance with the detection (YES in Step S3), the gas sensor 81 detects the O_2 concentration, the NOx concentration, the CO concentration, the CO_2 concentration, or the air ratio in the primary combustion region in

accordance with the sign (Step S4). The control unit 130 determines whether or not the O_2 concentration, the NOx concentration, the CO concentration, the CO_2 concentration, or the air ratio in the primary combustion region, which is detected by the gas sensor 81, is equal to or higher than a predetermined concentration or a predetermined air ratio (Step S5).

[0084]

In a case where the control unit 130 determines that the O_2 concentration, the NOx concentration, the CO concentration, the CO_2 concentration, or the air ratio in the primary combustion region, which is detected by the gas sensor 81, is equal to or higher than the predetermined concentration or the predetermined air ratio (YES in Step S5), the control unit 130 ends the process. In addition, in a case where the control unit 130 determines that the O_2 concentration, the NOx concentration, the CO concentration, the CO_2 concentration, or the air ratio in the primary combustion region, which is detected by the gas sensor 81, is lower than the predetermined concentration or the predetermined air ratio (NO in Step S5), the control unit 130 reduces the flow rate of the EGR to be mixed with the air charged into the secondary combustion region by controlling the flow rate of the first EGR nozzle 91 or the second EGR nozzle 93, for example (Step S6). Then, the detection unit 95 detects whether or not there is a sign of an increase in O_2, whether or not there is a sign of an increase in NOx, whether or not there is a sign of a decrease in CO, whether or not there is a sign of a decrease in CO_2, or whether or not there is a sign of an increase in the air ratio in the primary combustion region (Step S7).

[0085]

In a case where the detection unit 95 does not detect the sign (NO in Step S7), the process returns to Step S6. In addition, in a case where the detection unit 95 detects the sign (YES in Step S7), the gas sensor 81 detects the O_2 concentration, the NOx

concentration, the CO concentration, the CO_2 concentration, or the air ratio in the primary combustion region, which corresponds to the detected sign (Step S8). The control unit 130 determines whether or not the O_2 concentration, the NOx concentration, the CO concentration, the CO_2 concentration, or the air ratio in the primary combustion region, which is detected by the gas sensor 81, is equal to or higher than a predetermined concentration or a predetermined air ratio (Step S9).

[0086]

In a case where the control unit 130 determines that the O_2 concentration, the NOx concentration, the CO concentration, the CO_2 concentration, or the air ratio in the primary combustion region, which is detected by the gas sensor 81, is equal to or higher than the predetermined concentration or the predetermined air ratio (YES in Step S9), the control unit 130 ends the process. In addition, in a case where the control unit 130 determines that the O_2 concentration, the NOx concentration, the CO concentration, the CO_2 concentration, or the air ratio in the primary combustion region, which is detected by the gas sensor 81, is lower than the predetermined concentration or the predetermined air ratio (NO in Step S9), the control unit 130 controls the second EGR nozzle 93 to reduce the flow rate of the EGR discharged by the rear ceiling portion 57 by the second EGR nozzle 93 (Step S10). Then, the detection unit 95 detects whether or not there is a sign of an increase in O_2, whether or not there is a sign of an increase in NOx, whether or not there is a sign of a decrease in CO, whether or not there is a sign of a decrease in CO, or whether or not there is a sign of an increase in the air ratio in the primary combustion region (Step S11).

[0087]

In a case where the detection unit 95 does not detect the sign (NO in Step S11), the process returns to Step S10. In addition, in a case where the detection unit 95

detects the sign (YES in Step S11), the gas sensor 81 detects the O_2 concentration, the NOx concentration, the CO concentration, the CO_2 concentration, or the air ratio in the primary combustion region, which is the predetermined concentration or the predetermined air ratio (Step S12). The control unit 130 determines whether or not the O_2 concentration, the NOx concentration, the CO concentration, the CO_2 concentration, or the air ratio in the primary combustion region, which is detected by the gas sensor 81, is equal to or higher than a predetermined concentration or a predetermined air ratio (Step S13).

[0088]

In a case where the control unit 130 determines that the O_2 concentration, the NOx concentration, the CO concentration, the CO_2 concentration, or the air ratio in the primary combustion region, which is detected by the gas sensor 81, is equal to or higher than the predetermined concentration or the predetermined air ratio (YES in Step S13), the control unit 130 ends the process. In addition, in a case where the control unit 130 determines that the O_2 concentration, the NOx concentration, the CO concentration, the CO_2 concentration, or the air ratio in the primary combustion region, which is detected by the gas sensor 81, is lower than the predetermined concentration or the predetermined air ratio (NO in Step S13), the process returns to Step S10.

[0089]

Next, a process performed by the combustion facility 1 shown in FIG. 20 will be described. The detection unit 95 detects the deterioration in the combustion completeness performance (Step S21). The control unit 130 mixes the air with the EGR discharged by the first EGR nozzle 91 in accordance with the detection by the detection unit 95 to increase the O_2 concentration, to increase the NOx concentration, to decrease the CO concentration, to decrease the CO_2 concentration, or to increase the air ratio in the

primary combustion region (Step S22). The control unit 130 reduces the speed of the stoker 40 (Step S23). The control unit 130 controls the second EGR nozzle 93 to increase the flow rate of the EGR discharged by the second EGR nozzle 93 (Step S24). The control of the first EGR nozzle 91 and the second EGR nozzle 93 by the control unit 130 described with reference to FIG. 20 is an example, and the present disclosure is not limited thereto. For example, as described below, the increase/decrease direction of the flow rate of the EGR discharged by the second EGR nozzle 93 (that is, whether the flow rate is increased or decreased) may coincide with the increase/decrease direction of the O_2 concentration, the increase/decrease direction of the NOx concentration, the increase/decrease direction of the CO concentration, the increase/decrease direction of the CO_2 concentration, or the increase/decrease direction of the air ratio in the primary combustion region, or may be opposite to the increase/decrease direction.

[0090]

FIG. 21 is a diagram showing an image of a process performed by the control unit 130 according to the second embodiment of the present disclosure. A target air ratio is determined to balance the air ratio, and each gas amount is controlled by, for example, proportional integral differential (PID) control (a part of (a) of FIG. 21). Accordingly, the (primary) air under the grate bar is always controlled to be neither excessive nor insufficient with respect to the waste. A processing unit that executes the PID control may be, for example, a change amount determiner. The change amount determiner may execute at least one of P control, I control, and D control. In addition, the first gas for combustion and the second gas for combustion can be controlled with priorities as in the process flow (control logic) shown in FIG. 19 (a part of (b) of FIG. 21, a part of (c) of FIG. 21, and a part of (d) of FIG. 21). For example, in a case where the air ratio under the grate bar is 1.0, the air ratio of the first gas for combustion is 0.1, and

the air ratio of the second gas for combustion is 0.1, the target air amount can be individually adjusted with priorities within the range of the air ratio likelihood of each charged gas, and an optimal local air ratio state for reducing NOx is maintained. In a case where the quality and the amount of the waste on the grate bar are changed and the like, for example, in a case where the air under the grate bar decreases, control of simply increasing any one or both of the first and second gas for combustion may increase the NOx discharged by the EGR unit depending on the situation in the furnace, and thus reduction of NOx may not be achieved. It is necessary to increase or decrease according to the air ratio of the combustion field at the first and second gas for combustion blowing positions in consideration of a local deviation, a time delay, and the like. That is, the control unit 130 may control the second EGR nozzle 93 according to the state of the target air ratio inside the furnace body 30. Such control by the control unit 130 is different from the control of independently acting on each target value in an invention described in Patent Document 2 and increasing the gas amount of the intermediate nozzle portion in a case where the air under the grate bar is decreased.

[0091]

The combustion facility 1 according to the second embodiment of the present disclosure has been described above. The combustion facility 1 includes the detection unit 95 that detects a decrease in O_2 concentration in the primary combustion region, which is a region in the furnace body 30, and the control unit 130 that performs control to increase the O_2 concentration of the first gas for combustion in a case where the detection unit 95 detects the decrease in O_2 concentration in the primary combustion region, and performs control to increase the O_2 concentration of the second gas for combustion in a case where an increase in O_2 concentration in the primary combustion region or a sign of the increase is not detected even after the control is performed. With the combustion

facility 1, the NOx concentration and the CO concentration can be optimized.

[0092]

(Other Embodiments)

The combustion facility 1 according to another embodiment of the present disclosure may learn a relationship between a control amount and an outlet gas concentration by machine learning to detect a sign of improvement in exhaust gas performance. The control amount in this case is the flow rate of the air or the EGR to be mixed and the stoker speed.

[0093]

FIG. 22 is a hardware configuration diagram showing a configuration of a computer 1100 according to the embodiment. For example, the computer 1100 includes a processor 1110, a main memory 1120, a storage 1130, and an interface 1140.

[0094]

Each functional unit of the control device 100 is installed in the computer 1100. An operation of each functional unit described above is stored in the storage 1130 in a form of a program. The processor 1110 reads the program from the storage 1130, loads the program into the main memory 1120, and executes the above-described processing in accordance with the program. In addition, the processor 1110 secures a storage area that is used by each of the above-described functional units in the main memory 1120 in accordance with the program.

[0095]

The program may be used for realizing some of the functions to be exhibited by the computer 1100. For example, the program may exhibit a function in combination with another program already stored in the storage 1130 or in combination with another program mounted on another device. In addition, the computer 1100 may include a

custom large scale integrated circuit (LSI) such as a programmable logic device (PLD) in addition to or in place of the above-described configuration. As examples of the PLD, a programmable array logic (PAL), a generic array logic (GAL), a complex programmable logic device (CPLD), a field programmable gate array (FPGA), and the like can be given. In this case, some or all of the functions realized by the processor 1110 may be realized by the integrated circuit.

[0096]

As an example of the storage 1130, a magnetic disk, a magneto-optical disk, a semiconductor memory, and the like can be given. The storage 1130 may be an internal medium directly connected to a bus of the computer 1100 or may be an external medium connected to the computer 1100 through the interface 1140 or a communication line. Further, in a case where this program is distributed to the computer 1100 via a communication line, the computer 1100 that has received the distribution may load the program into the main memory 1120 and execute the above-described processing. In addition, the program may be used for realizing some of the above-described functions. Further, the program may be a so-called differential file (differential program) that realizes the above-described functions in combination with another program already stored in the storage 1130.

[0097]

(Supplementary Note)

The combustion facility and the control method described in each embodiment are understood as follows, for example.

[0098]

(1) A combustion facility (1) of a first aspect includes a furnace (60) into which gas after combustion flows, a furnace body (30) including a drying stage (30a), a

combustion stage (30b), and a post-combustion stage (30c) and configured to convey an object to be incinerated (S) while combusting the object to be incinerated (S), the furnace body (30) including, in a case where an upstream side in a conveyance direction of the object to be incinerated (S) is referred to as front and a downstream side in the conveyance direction of the object to be incinerated (S) is referred to as rear, a front ceiling portion (55) extending forward from the furnace (60), a rear ceiling portion (57) extending rearward from the furnace (60), and a rear wall (59) extending downward from a rear end portion of the rear ceiling portion (57), a first nozzle (91) provided in a region of the rear ceiling portion (57) rearward of a center of the rear ceiling portion (57) in the conveyance direction or in the rear wall (59), and configured to discharge a first gas for combustion forward, a second nozzle (93) provided at a position forward of the first nozzle (91) in the rear ceiling portion (57) and configured to discharge a second gas for combustion from the rear ceiling portion (57) toward the drying stage (30a) or the combustion stage (30b), and a control unit (130) configured to control an amount of the second gas for combustion discharged by the second nozzle (93) based on a target air ratio in a primary combustion region that is a region in the furnace body (30).

[0099]

According to such a configuration, the flow of the first gas for combustion discharged by the first nozzle is changed by the second gas for combustion discharged by the second nozzle. Therefore, the method of mixing air and EGR is changed, and the combustion of the object to be incinerated can be promoted. As a result, for example, appropriate combustion such as reduction of NOx can be realized.

[0100]

(2) In a combustion facility (1) of a second aspect, in the combustion facility (1) according to (1), the second nozzle (93) may be provided in a region of the rear ceiling

portion (57) forward of the center of the rear ceiling portion (57) in the conveyance direction.

[0101]

According to such a configuration, the second nozzle can be more appropriately installed.

[0102]

(3) In a combustion facility (1) of a third aspect, in the combustion facility according to (2), in a case where the rear ceiling portion (57) is virtually divided into four regions in the conveyance direction, the second nozzle (93) may be provided in a frontmost region among the four divided regions.

[0103]

According to such a configuration, the second nozzle can be more appropriately installed.

[0104]

(4) In a combustion facility (1) of a fourth aspect, in the combustion facility (1) according to any one of (1) to (3), in a case where a forward direction in a horizontal direction is defined as 0°, the second nozzle (93) may discharge the second gas for combustion in a direction included in an angular range of 60° or more and 90° or less with respect to the horizontal direction.

[0105]

According to such a configuration, the second nozzle can be more appropriately installed.

[0106]

(5) In a combustion facility (1) of a fifth aspect, the combustion facility (1) according to any one of (1) to (4) may further include a plurality of first nozzles (91) that

include the first nozzle (91), that are provided in the region of the rear ceiling portion (57) rearward of the center of the rear ceiling portion (57) in the conveyance direction, or in the rear wall (59), and that discharge the first gas for combustion forward, and a plurality of virtual lines extending forward from the plurality of first nozzles (91) may be defined, and the second nozzle (93) may be disposed between the plurality of virtual lines as viewed from above.

[0107]

According to such a configuration, it is possible to reduce interference between the first gas for combustion discharged by the first nozzle and the second gas for combustion discharged by the second nozzle.

[0108]

(6) In a combustion facility (1) of a sixth aspect, in the combustion facility (1) according to any one of (1) to (5), the first nozzle (91) may be provided in the rear wall (59) and may discharge the first gas for combustion in an orientation in which a wall jet along the rear ceiling portion (57) is formed.

[0109]

According to such a configuration, it is possible to promote the mixing of the first gas for combustion discharged by the first nozzle and the air.

[0110]

(7) In a combustion facility (1) of a seventh aspect, the combustion facility (1) according to any one of (1) to (6) may further include a detection unit (95) that detects a decrease in oxygen concentration in the primary combustion region, in which the control unit (130) may perform control to increase oxygen concentration of the first gas for combustion in a case where the detection unit (95) detects the decrease in oxygen concentration in the primary combustion region, and may perform control to increase

oxygen concentration of the second gas for combustion in a case where an increase in oxygen concentration in the primary combustion region or a sign of the increase is not detected even after the control is performed.

[0111]

According to such a configuration, the NOx concentration and the CO concentration can be optimized.

[0112]

(8) In a combustion facility (1) of an eighth aspect, the combustion facility (1) according to any one of (1) to (7) may further include an angle adjustment mechanism (97) that is capable of changing a discharge direction of the second gas for combustion from the second nozzle (93), a sensor (81) configured to detect a component contained in the gas after combustion or gas that has passed through the furnace (60), and a control unit (130) configured to control the angle adjustment mechanism (97) based on a detection result of the sensor (81).

[0113]

According to such a configuration, the orientation of the second gas for combustion discharged by the second nozzle can be appropriately adjusted.

[0114]

(9) A control method of a ninth aspect is a control method for a combustion facility (1), the combustion facility (1) including a furnace (60) into which gas after combustion flows, a furnace body (30) including a drying stage (30a), a combustion stage (30b), and a post-combustion stage (30c) and configured to convey an object to be incinerated (S) while combusting the object to be incinerated (S), the furnace body (30) including, in a case where an upstream side in a conveyance direction of the object to be incinerated (S) is referred to as front and a downstream side in the conveyance direction

of the object to be incinerated (S) is referred to as rear, a front ceiling portion (55) extending forward from the furnace (60), a rear ceiling portion (57) extending rearward from the furnace (60), and a rear wall (59) extending downward from a rear end portion of the rear ceiling portion (57), a first nozzle (91) provided in a region of the rear ceiling portion (57) rearward of a center of the rear ceiling portion (57) in the conveyance direction or in the rear wall (59) and configured to discharge a first gas for combustion forward, a second nozzle (93) provided at a position forward of the first nozzle (91) in the rear ceiling portion (57) and configured to discharge a second gas for combustion from the rear ceiling portion (57) toward the drying stage (30a) or the combustion stage (30b), the control method including controlling, by one or more computers (1100), an amount of the second gas for combustion discharged by the second nozzle (93) based on a target air ratio in a primary combustion region that is a region in the furnace body (30).

[0115]

According to such a configuration, the flow of the first gas for combustion discharged by the first nozzle is changed by the second gas for combustion discharged by the second nozzle. Therefore, the method of mixing air and EGR is changed, and the combustion of the object to be incinerated can be promoted. As a result, for example, appropriate combustion such as reduction of NOx can be realized.

Industrial Applicability

[0116]

According to the system for a combustion facility and the combustion control method of the present disclosure, it is possible to realize appropriate combustion.

Reference Signs List

[0117]

1 Combustion facility

2 Storage unit

3 Incinerator

11 Waste pit

12 Crane

21 Hopper

22 Feeder

23 Extrusion device

24 Moisture meter

25 Water sprinkler device

30 Furnace body

31 Furnace temperature sensor

32 Visible light camera

33 Infrared camera

40 Stoker

50 Wind box

51 Wind box pressure sensor

55 Front ceiling portion

57 Rear ceiling portion

59 Rear wall

60 Furnace

60a Front wall

60b Rear wall

70 Blowing mechanism

71 Blower

73 Air preheater

75 Damper

81 Gas sensor

91 First EGR nozzle

93 Second EGR nozzle

95 Detection unit

97 Angle adjustment mechanism

100 Control device

110 Information acquisition unit

120 Flame information derivation unit

130 Control unit

140 Powder layer height derivation unit

S Object to be incinerated

CLAIMS

[Claim 1] A combustion facility comprising:

a furnace into which gas after combustion flows;

a furnace body including a drying stage, a combustion stage, and a post-combustion stage and configured to convey an object to be incinerated while combusting the object to be incinerated, the furnace body including, in a case where an upstream side in a conveyance direction of the object to be incinerated is referred to as front and a downstream side in the conveyance direction is referred to as rear, a front ceiling portion extending forward from the furnace, a rear ceiling portion extending rearward from the furnace, and a rear wall extending downward from a rear end portion of the rear ceiling portion;

a first nozzle provided in a region of the rear ceiling portion rearward of a center of the rear ceiling portion in the conveyance direction or in the rear wall and configured to discharge a first gas for combustion forward;

a second nozzle provided at a position forward of the first nozzle in the rear ceiling portion and configured to discharge a second gas for combustion from the rear ceiling portion toward the drying stage or the combustion stage; and

a control unit configured to control an amount of the second gas for combustion discharged by the second nozzle based on a target air ratio in a primary combustion region that is a region in the furnace body.

[Claim 2] The combustion facility according to Claim 1,

wherein the second nozzle is provided in a region of the rear ceiling portion forward of the center of the rear ceiling portion in the conveyance direction.

[Claim 3] The combustion facility according to Claim 2,

wherein, in a case where the rear ceiling portion is virtually divided into four regions in the conveyance direction, the second nozzle is provided in a frontmost region among the four divided regions.

[Claim 4] The combustion facility according to any one of Claims 1 to 3,

wherein the second nozzle is configured to, in a case where a forward direction in a horizontal direction is defined as 0°, discharge the second gas for combustion in a direction included in an angular range of 60° or more and 90° or less with respect to the horizontal direction.

[Claim 5] The combustion facility according to any one of Claims 1 to 3,

wherein the combustion facility includes a plurality of first nozzles including the first nozzle, the plurality of first nozzles being provided in the region of the rear ceiling portion rearward of the center of the rear ceiling portion in the conveyance direction or in the rear wall and configured to discharge the first gas for combustion forward, and

a plurality of virtual lines extending forward from the plurality of first nozzles are defined, and the second nozzle is disposed between the plurality of virtual lines as viewed from above.

[Claim 6] The combustion facility according to any one of Claims 1 to 3,

wherein the first nozzle is provided in the rear wall and is configured to discharge the first gas for combustion in an orientation in which a wall jet along the rear ceiling portion is formed.

[Claim 7] The combustion facility according to any one of Claims 1 to 3, further comprising:

a detection unit configured to detect a decrease in oxygen concentration in the primary combustion region,

wherein the control unit is configured to:

perform control to increase oxygen concentration of the first gas for combustion in a case where the detection unit detects the decrease in oxygen concentration in the primary combustion region; and

perform control to increase oxygen concentration of the second gas for combustion in a case where an increase in oxygen concentration in the primary combustion region or a sign of the increase is not detected even after the control is performed.

[Claim 8] The combustion facility according to any one of Claims 1 to 3, further comprising:

an angle adjustment mechanism configured to change a discharge direction of the second gas for combustion from the second nozzle;

a sensor configured to detect a component contained in the gas after combustion or gas that has passed through the furnace; and

a control unit configured to control the angle adjustment mechanism based on a detection result of the sensor.

[Claim 9] A control method for a combustion facility, the combustion facility including a furnace into which gas after combustion flows, a furnace body including a drying stage, a combustion stage, and a post-combustion stage and configured to convey

an object to be incinerated while combusting the object to be incinerated, the furnace body including, in a case where an upstream side in a conveyance direction of the object to be incinerated is referred to as front and a downstream side in the conveyance direction is referred to as rear, a front ceiling portion extending forward from the furnace, a rear ceiling portion extending rearward from the furnace, and a rear wall extending downward from a rear end portion of the rear ceiling portion, a first nozzle provided in a region of the rear ceiling portion rearward of a center of the rear ceiling portion in the conveyance direction or in the rear wall and configured to discharge a first gas for combustion forward, a second nozzle provided at a position forward of the first nozzle in the rear ceiling portion and configured to discharge a second gas for combustion from the rear ceiling portion toward the drying stage or the combustion stage, the control method comprising:

controlling, by one or more computers, an amount of the second gas for combustion discharged by the second nozzle based on a target air ratio in a primary combustion region that is a region in the furnace body.