

CONTROL DEVICE AND CONTROL METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

5 [0001]

The present disclosure relates to a control device and a control method.

Description of Related Art

[0002]

10 Japanese Unexamined Patent Application, First Publication No. H08-106509
discloses a method as follows. A radiation temperature measuring instrument is
provided on a downstream side in a transport direction in which garbage is transported by
a stoker including a drying zone, a combustion zone, and a post-combustion zone. A
height of the garbage is estimated from a temperature distribution detected by the
15 radiation temperature measuring instrument. A property of the garbage is estimated,
based on the estimated height of the garbage or a temperature of the garbage. For
example, Japanese Unexamined Patent Application, First Publication No. H08-106509
discloses the following method. When the temperature of the garbage dropped from the
drying zone is low, the method estimates that the garbage has a large water content and is
20 less likely to burn. When the property of the garbage can be grasped, combustion
efficiency can be improved by adjusting a feeding speed of the garbage of the stoker or a
supply amount of combustion air. However, in the method disclosed in Japanese
Unexamined Patent Application, First Publication No. H08-106509, since garbage
quality is determined at a timing at which the garbage passes through the drying zone
25 after the garbage is loaded into a furnace, combustion control in the subsequent

combustion zone is not completed in time, and there is a possibility that combustion deterioration cannot be sufficiently improved.

[0003]

In addition, factors by which the combustion of the garbage deteriorates include

- 5 (1) partial misfire or an ignition delay due to shortage of garbage (insufficient combustible garbage) and (2) a loading of low-quality garbage (garbage which is less likely to burn, such as garbage having a low LHV and a high moisture content). In (1) and (2), required responses are different, and the combustion further deteriorates when an opposite operation is performed. Japanese Unexamined Patent Application, First
10 Publication No. H08-106509 does not disclose a method for estimating the property of the garbage by distinguishing between (1) and (2).

SUMMARY OF THE INVENTION

[0005]

- 15 In order to highly accurately perform combustion control, it is required to provide a technique of distinguishing and detecting shortage of garbage and low-quality garbage.

[0006]

- The present disclosure provides a control device and a control method which
20 are capable of solving the above-described problems.

[0007]

- According to the present disclosure, there is provided a control device of a garbage incineration facility. The control device includes a height acquisition unit configured to acquire a garbage layer height inside a furnace, an LHV acquisition unit
25 configured to acquire an LHV of garbage to be loaded into the furnace before the garbage

is loaded, an O₂ concentration acquisition unit configured to acquire an oxygen concentration inside the furnace, a determination unit configured to determine combustion deterioration by distinguishing between combustion deterioration resulting from shortage of garbage and combustion deterioration resulting from loading of garbage which is less likely to burn, by using the garbage layer height, the LHV, and the oxygen concentration, and a control unit configured to perform control for increasing a supply amount of the garbage when it is determined that the combustion deterioration results from the shortage of garbage, and configured to perform control for promoting combustion of the garbage when it is determined that the combustion deterioration results from the loading of the garbage which is less likely to burn.

[0008]

According to the present disclosure, there is provided a control method of a garbage incineration facility. The control method includes acquiring a garbage layer height inside a furnace, acquiring an LHV of garbage to be loaded into the furnace before the garbage is loaded, acquiring an oxygen concentration inside the furnace, determining combustion deterioration by distinguishing between combustion deterioration resulting from shortage of garbage and combustion deterioration resulting from loading of garbage which is less likely to burn, by using the garbage layer height, the LHV, and the oxygen concentration, and performing control for increasing a supply amount of the garbage when it is determined that the combustion deterioration results from the shortage of garbage, and performing control for promoting combustion of the garbage when it is determined that the combustion deterioration results from the loading of the garbage which is less likely to burn.

[0009]

According to the control device and the control method of the present

disclosure, it is possible to distinguish and detect combustion deterioration resulting from shortage of garbage and combustion deterioration resulting from low-quality garbage.

BRIEF DESCRIPTION OF THE DRAWINGS

5 [0010]

FIG. 1 is a diagram showing an example of a configuration of a combustion facility according to an embodiment.

FIG. 2 is a diagram showing a grate bar according to the embodiment.

FIG. 3 is a block diagram showing a functional configuration of a control
10 device according to the embodiment.

FIG. 4A is a first diagram showing a flow of garbage combustion inside a furnace.

FIG. 4B is a second diagram showing a flow of garbage combustion inside the furnace.

FIG. 5 is a flowchart showing an example of combustion control according to
15 the embodiment.

FIG. 6 is a diagram showing an example of a hardware configuration of the control device of the embodiment.

20 DETAILED DESCRIPTION OF THE INVENTION

[0011]

Hereinafter, embodiments of the present disclosure will be described with reference to the drawings. In the following description, the same reference numerals will be assigned to configurations having the same or similar functions. In some cases,
25 a repeated description of the configurations may be omitted. The following

embodiments do not limit the present invention in the appended claims. In addition, all combinations of features described in the embodiments are not essential for the solution of the invention.

[0012]

5 In the present disclosure, “based on XX” means “at least based on XX”, and may also include a case 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 any one of XX and YY, and may also include a
10 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 any elements (for example, any information).

[0013]

In the present application, the term “acquire” is not limited to a case where
15 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 device. In addition, the “acquisition” is not limited to a case where target information (acquisition target information) is directly acquired from the outside, and may also include a case where the target information is generated and
20 acquired by performing calculation, processing, or the like on the information obtained from the outside.

[0014]

In addition, in the embodiment described below, for convenience of description, a side on which a furnace body 30 is located with respect to a hopper 21 (to be described
25 later) will be defined as “rear”, and a side opposite thereto will be defined as “front”. In

the following description, for convenience of description, an upstream side in a transport direction of garbage may be referred to as “front”, and a downstream side in the transport direction may be referred to as “rear” in some cases. In addition, a "front side" may be referred to as a "furnace front side", and a "rear side" may be referred to as a "furnace rear side" in some cases. In addition, "left" and "right" will be defined, based on a direction from the hopper 21 toward the furnace body 30.

[0015]

<Embodiment>

Hereinafter, control for a garbage combustion facility of the present disclosure will be described with reference to the drawings.

(Overall Configuration of Combustion Facility)

FIG. 1 is a diagram showing an example of a configuration of a combustion facility according to an embodiment. For example, a combustion facility 1 is a stoker furnace in which municipal garbage, industrial waste, and the like are treated as an incineration object S. The combustion facility 1 is not limited to the stoker furnace, and may be other types of the combustion facility. In the following description, for convenience of description, the "incineration object" may be referred to as "garbage" in some cases. For example, the combustion facility 1 includes a control device 2, an incinerator 3, a heat recovery steam generator 4, a cooling tower 5, a dust collector 6, a flue 7, and a chimney 8.

[0016]

The incinerator 3 is a furnace that combusts the incineration object S while transporting the incineration object S loaded from a storage section (not shown) that temporarily stores the collected incineration object S. As a result of the combustion of the incineration object S inside the incinerator 3, an exhaust gas is generated 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 and generates steam by performing heat exchange between the exhaust gas generated in the incinerator 3 and the water. The exhaust gas passing through the heat recovery steam generator 4 is cooled by the cooling tower 5, and thereafter, is fed to the dust collector 6. The exhaust gas is discharged to the atmosphere through the flue 7 and the chimney 8 after soot and dust are removed by the dust collector 6.

[0017]

For example, the incinerator 3 includes a supply mechanism 20, a furnace body 30, a stoker 40, a discharge chute 43, a plurality of wind boxes 50a to 50e, a furnace 60, a blower mechanism 70, a first EGR nozzle 91, and a second EGR nozzle 93.

[0018]

The supply mechanism 20 temporarily stores the incineration object S loaded from a storage section (not shown), and sequentially supplies the incineration object S to a processing space V of the furnace body 30 (to be described later). For example, the supply mechanism 20 includes a hopper 21, a feeder 22, an LHV measuring instrument 23, and a sprinkling device 24. The LHV measuring instrument is provided in a bottom portion of the hopper 21, and measures a lower heating value (LHV) [kJ/kg] of the garbage immediately before the garbage is loaded into the furnace in which the garbage is crushed by the garbage in an upper layer inside the hopper 21 and moisture is removed. A measurement value of the LHV is output to the control device 2.

[0019]

The hopper 21 is a storage section provided to supply the incineration object S into the furnace body 30. The hopper 21 includes an inlet portion for loading the incineration object S and an outlet portion that communicates with the processing space

V of the furnace body 30 (to be described later). The incineration object S transported by a crane is loaded into the hopper 21.

[0020]

The feeder 22 is provided in a bottom portion of the hopper 21. For example,
5 the feeder 22 is formed in a plate shape along the bottom portion of the hopper 21. The feeder 22 is driven by the control device 2, and is reciprocally movable in a direction from the hopper 21 toward the processing space V of the furnace body 30. The feeder 22 pushes out the incineration object S deposited inside the hopper 21 toward the processing space V of the furnace body 30. The LHV measuring instrument 23 detects
10 the LHV of the incineration object S loaded into the hopper 21. The sprinkling device 24 adjusts the moisture content of the incineration object S by sprinkling water on the incineration object S.

[0021]

The furnace body 30 is provided adjacent to the hopper 21, and combusts the
15 incineration object S while transporting the incineration object S. Hereinafter, a transport direction of the incineration object S in the combustion facility 1 will be referred to as a “transport direction D”. The transport direction D may be referred to as a “depth direction”.

[0022]

20 The furnace body 30 includes a drying section 30a, a combustion section 30b, and a post-combustion section 30c in this order from an upstream side to a downstream side in the transport direction D. The furnace body 30 transports the incineration object S from the upstream side to the downstream side while combusting the incineration object S. The drying section 30a is a region located on the upstream side of the
25 combustion section 30b and the post-combustion section 30c and drying the incineration

object S supplied from the hopper 21, before the incineration object S is combusted on the stoker 40. The combustion section 30b and the post-combustion section 30c are regions in which the incineration object S passing through the drying section 30a and brought into a dried state is combusted on the stoker 40. In the combustion section 30b, diffusion combustion using a thermolysis gas generated from the incineration object S occurs, and a flame F is generated. In the post-combustion section 30c, since fixed carbon combustion occurs after the diffusion combustion of the incineration object S, the flame F is not generated.

[0023]

For example, the furnace body 30 includes an in-furnace temperature sensor 31 and an in-furnace pressure sensor 35. For example, the in-furnace temperature sensor 31 is a thermocouple, and measures a temperature inside the furnace body 30 (may be referred to as an “in-furnace” in some cases). The in-furnace pressure sensor 35 measures a pressure inside the furnace body 30. A plurality of the in-furnace temperature sensors 31 may be provided. Positions of the in-furnace pressure sensor 35 and the in-furnace temperature sensor 31 are not limited thereto, and may be provided at other positions.

[0024]

For example, the furnace body 30 includes a visible light camera 32 and an infrared camera 33. The visible light camera 32 and the infrared camera 33 capture an internal image of the furnace body 30. For example, the visible light camera 32 and the infrared camera 33 are provided in end portions (hereinafter, referred to as a “furnace rear side”) on the downstream side of the furnace body 30 in the transport direction D, and image the upstream side in the transport direction D from the furnace rear side.

Imaging results of the visible light camera 32 and the infrared camera 33 are transmitted

to the control device 2.

[0025]

The stoker 40 includes a plurality of grate bars 41. The plurality of grate bars 41 form a stoker surface 40a that is a bottom surface of the furnace body 30. The incineration object S 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 section 30a, the combustion section 30b, and the post-combustion section 30c which are described above. The plurality of grate bars 41 include a stationary grate bar and a movable grate bar. The stationary grate bars are fixed to upper surfaces of wind boxes 50a to 50e (to be described later). The movable grate bar reciprocates along the transport direction D at a constant speed, and transports the incineration object S located on the movable grate bar and the stationary grate bar (on the stoker surface 40a) to the downstream side while stirring and mixing the incineration object S.

[0026]

The plurality of grate bars 41 will be described with reference to FIG. 2. The plurality of grate bars 41 includes a plurality of sets of movable grate bars 41a and stationary grate bars 41b in which the movable grate bar 41a and the stationary grate bar 41b are used as one set. Each of the movable grate bars 41a performs a reciprocating operation in a direction of an arrow 41c, and the stationary grate bars 41b do not move while being fixed. A surface (stoker surface 40a) on which the garbage of the movable grate bar 41a and the stationary grate bar 41b is placed is inclined such that the incineration object S is lifted with respect to the transport direction of the incineration object S, and an inclination angle θ of the placement surface is in a range of $0^\circ < \theta \leq 20^\circ$. While the incineration object S is transported from the left to the right of the paper surface on the stoker surface 40a, the control device 2 causes the movable grate bar 41a

to reciprocate in the direction of the arrow 41c. In this manner, the incineration object S is transported to the right side of the paper surface. In the present embodiment, in addition to this normal control, control for rapidly increasing a speed of the reciprocating operation of the movable grate bar 41a is performed in accordance with a property of the garbage (in a case of low-quality garbage). In this case, the incineration object S placed on the movable grate bar 41a moves in a direction indicated by an arrow 41d. That is, in the incineration objects S placed on the stoker surface 40a, the garbage on a bottom surface side is lifted and moves to a surface side, covers an upper portion of the garbage on the surface side, and the garbage located on the surface side so far moves to the bottom surface side. That is, a flow in which combusted garbage (bottom surface side) rotates counterclockwise to cover newly loaded garbage (surface side) is generated, and a combustion promoting effect is improved. The reason that the garbage rotates counterclockwise is that a vertical wall 41e is present in an end portion of the stoker 40 and the grate bar 41 faces obliquely upward. The incineration object S on the surface side is not combusted much, compared to the bottom surface side. The movable grate bar and the stationary grate bar are alternately aligned. In this manner, a movement (combustion promotion of an intermediate layer) is generated such that the ignited garbage on the surface is pushed into a lower layer of a garbage layer, and the ignited garbage on the surface is buried in the intermediate layer. In this manner, the garbage is continuously combusted inside the garbage layer, thereby leading to an effect of promoting the combustion in the intermediate layer. Since this reciprocating operation is performed at a high speed while the incineration object S is transported, the incineration object S can be stirred and uniformly combusted.

[0027]

The discharge chute 43 is a device that drops the incineration object S, which

has been completely combusted to ash, to an ash pushing device located below the furnace body 30. The discharge chute 43 is provided on the furnace rear side of the furnace body 30.

[0028]

5 The plurality of wind boxes 50a to 50e are provided below the stoker 40, and primary air for combustion is supplied into the furnace body 30 through the stoker 40. In the present embodiment, the plurality of wind boxes 50a to 50e are aligned in the transport direction D, for example, corresponding to the plurality of grate bars 41. The wind box 50a is provided with a wind box pressure sensor 51a that measures a pressure
10 inside the wind box 50a. The pressure inside the wind box 50a corresponds to the pressure of the primary air supplied from the wind box 50a into the furnace body 30. Similarly, the wind boxes 50b, 50c, 50d, and 50e are provided with corresponding wind box pressure sensors 51b, 51c, 51d, and 51e. In some cases, the wind boxes 50a to 50e may be collectively referred to as a wind box 50, and the wind box pressure sensors 51a
15 to 51e may be collectively referred to as a wind box pressure sensor 51.

[0029]

 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 combustion of the
20 incineration object S inside the furnace body 30 flows to the heat recovery steam generator 4 through the furnace 60. A furnace outlet-side temperature sensor 36 that measures a temperature of the gas discharged from the furnace 60 is provided on an outlet side of the furnace 60. A flow rate sensor 37 that measures the flow rate of the exhaust gas is provided on an inlet side of the heat recovery steam generator 4, and a
25 flow rate sensor 38 that measures the amount of steam generated by the heat recovery

steam generator 4 is provided on an outlet side of the heat recovery steam generator 4.

In addition, in the present embodiment, the heat recovery steam generator 4 can measure a boiler drum level indicating a water level of the heat recovery steam generator 4. The

furnace 60 includes a front wall 60a located on a front side of a space through which the

5 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 a vertical direction. When the upstream side of the incineration object S in the

transport direction is referred to as “front” and the downstream side in the transport

direction is referred to as “rear”, the furnace 60 includes a front ceiling section 55

10 extending forward from the furnace 60, a rear ceiling section 57 extending rearward from

the furnace 60, and a rear wall 59 extending downward from a rear end portion of the

rear ceiling section 57. This space will be referred to as a primary combustion chamber.

In addition, a space connected to an outlet side of the primary combustion chamber and

forming a lower portion of the furnace 60 will be referred to as a secondary combustion

15 chamber.

[0030]

The blower mechanism 70 supplies combustion air into the furnace body 30

and the furnace 60. For example, the blower mechanism 70 includes a blower 71, a

primary air line 72, an air preheater 73, a secondary air line 74, a damper 75, and an air

20 flow rate sensor 76.

[0031]

The blower 71 is a push 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 primary air for combustion into

25 the furnace body 30 (for example, the processing space V and the primary combustion

chamber) through the primary air line 72 and the plurality of wind boxes 50a to 50e.

The second blower 71B pumps secondary air for combustion into the furnace 60 (for example, a processing space V' and the secondary combustion chamber) through the secondary air line 74.

5 [0032]

The primary air line 72 connects the first blower 71A and the plurality of wind boxes 50a to 50e. One or more (for example, a plurality of) primary air dampers 75A are provided in an intermediate portion of the primary air line 72. In the present embodiment, the plurality of primary air dampers 75a to 75e are provided to correspond
10 to the plurality of wind boxes 50a to 50e 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 50a corresponding to the primary air damper 75a, depending on an opening degree of the primary air damper 75a. The same applies to the primary air dampers 75b to 75e.

15 [0033]

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 an intermediate portion of the primary air line 72. The air preheater 73 includes a preheating temperature sensor 73a that measures the temperature of the preheated
20 primary air.

[0034]

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 on the front wall 60a of the
25 furnace 60, and supplies the secondary air from the front wall 60a of the furnace 60 to a

space (exhaust gas flow path) inside the furnace 60. On the other hand, the second supply port 74b is open on the rear wall 60b of the furnace 60, and the secondary air is supplied from the rear wall 60b of the furnace 60 to the space (exhaust gas flow path) inside the furnace 60. One or more (for example, a plurality of) secondary air dampers 5 75B are provided in the intermediate portion of the secondary air line 74.

[0035]

The air flow rate sensor 76 measures a flow rate of the combustion air supplied into the furnace body 30 and the furnace 60. For example, the air flow rate sensor 76 includes a first air flow rate sensor 76A and a second air flow rate sensor 76B. The first 10 air flow rate sensor 76A is provided in the intermediate portion of the primary air line 72, and measures the flow rate of the primary air supplied through the primary air line 72. The second air flow rate sensor 76B is provided in the intermediate portion of the secondary air line 74, and measures the flow rate of secondary air supplied through the secondary air line 74. The first air pressure sensor 77 measures the pressure of the 15 combustion air supplied into the furnace body 30. The first air pressure sensor 77 is provided in the intermediate portion of the primary air line 72, and measures the pressure of the primary air supplied through the primary air line 72.

[0036]

The gas sensor 81 detects a component in the exhaust gas. For example, the 20 gas sensor 81 can detect an oxygen concentration (hereinafter, referred to as an “O₂ concentration”), a carbon monoxide concentration (hereinafter, referred to as a “CO concentration”) (non-combusted portion), a carbon dioxide concentration (hereinafter, referred to as a “CO₂ concentration”), an NO_x concentration, an air ratio in a primary combustion region, and the like which are contained in the exhaust gas. For example, 25 the gas sensor 81 is provided in the flue 7, but may be provided inside the chimney 8, or

may be provided at another place (for example, a place where the gas after combustion can be detected, such as the outlet side of the heat recovery steam generator 4).

[0037]

5 The first EGR nozzle 91 is provided in a region behind the center of the rear ceiling section 57 in the transport direction of the incineration object S in the rear ceiling section 57 or on the rear wall 59 extending downward from a rear end portion of the rear ceiling section 57. The first EGR nozzle 91 discharges EGR, the air, or EGR mixed with the air forward.

[0038]

10 The second EGR nozzle 93 is provided at a position on the front side with respect to the first EGR nozzle 91 in the rear ceiling section 57. The second EGR nozzle 93 discharges the EGR, the air, or the EGR mixed with the air (example of the second combustion gas) from the rear ceiling section 57 toward the drying section 30a or the combustion section 30b. The second EGR nozzle 93 includes an angle adjustment
15 mechanism 97 that can change a discharge direction of the EGR.

[0039]

(Control Device)

Next, the control device 2 will be described. FIG. 3 is a block diagram showing a functional configuration of the control device 2. The control device 2
20 acquires measurement values from various sensors (in-furnace temperature sensor 31, visible light camera 32, infrared camera 33, in-furnace pressure sensor 35, furnace outlet-side temperature sensor 36, flow rate sensor 37, flow rate sensor 38, wind box pressure sensor 51, preheating temperature sensor 73a, air flow rate sensor 76, first air pressure sensor 77, gas sensor 81, and boiler drum level of the heat recovery steam generator 4)
25 provided in the combustion facility 1, and controls the combustion facility 1. For

example, the control device 2 performs combustion control for the incineration object S in the furnace body 30. The control device 2 has various functions, but only functions related to the control according to the present embodiment will be described.

[0040]

5 The control device 2 includes a height acquisition unit 2a, an LHV acquisition unit 2b, an O₂ concentration acquisition unit 2c, a combustion determination unit 2d, and a control unit 2e.

 The height acquisition unit 2a acquires a height of the garbage layer laminated on the stoker 40. The garbage height acquisition unit 2a estimates the height of the
10 garbage layer of the furnace body 30, based on an image of the furnace body 30 which is captured by the infrared camera 33. In the image captured by the infrared camera 33 at a certain wavelength, the garbage laminated on the stoker 40 appears black. A mark is set for a feature point, a structure, or the like inside the furnace which is included in the image captured in advance by the infrared camera 33, and a distance (height) from the
15 stoker surface 40a of the mark is measured. The height acquisition unit 2a estimates the height of the garbage layer laminated on the stoker 40, based on a positional relationship between the mark appearing in the image and an upper end side of a black portion (garbage layer). In addition, the height of the garbage layer has a relationship with a pressure loss of the primary air which is caused by the garbage layer. That is, as the
20 height of the garbage layer becomes higher, the pressure loss occurs, and when an opening degree of the primary air damper 75a is the same, the pressure measured by the in-furnace pressure sensor 35 is lowered as the height of the garbage layer becomes higher. In order to grasp the pressure loss of the garbage layer, it is conceivable that the pressure loss of the garbage is a remaining value obtained by subtracting the pressure
25 measured by the in-furnace pressure sensor 35 from the pressure measured by the wind

box pressure sensor 51 and further subtracting the pressure loss caused by the stoker 40 from a value obtained after the subtraction. However, in practice, when the primary air passes directly above the wind box 50, a leak may occur in the adjacent wind box 50 on the downstream side, or a leak may occur in the other wind box 50. Therefore, it is not possible to accurately grasp the pressure loss of the garbage layer with only a difference in a pressure measurement value in the vertical direction, and there is a deviation in the estimation of the garbage layer height based on the pressure loss. Therefore, in the present embodiment, the pressure loss of the garbage layer is estimated in view of the leak between the wind boxes, and the height of the garbage layer is estimated, based on the estimated pressure loss. The height acquisition unit 2a estimates the height of the garbage layer from the image, and corrects the garbage layer height estimated from the image by using the garbage height estimated from the pressure loss. The present embodiment is not limited only to a method for correcting the garbage layer height estimated from the image by using the garbage layer height estimated from the pressure loss, and the height estimated from the image may be used as the height of the garbage layer, or the height estimated from the pressure loss may be used as the height of the garbage layer.

[0041]

For example, through a ventilation test, a relationship analyzed in advance among the pressure measured by the first air pressure sensor 77, the opening degrees of the primary air dampers 75a to 75e, the pressures measured by the wind box pressure sensors 51a to 51e, the pressure losses of the primary air dampers 75a to 75e, the flow rate of the primary air in the vertical direction in view of a leak flow rate of the primary air between the wind boxes 50 adjacent to each other (holes are open in the wind boxes 50a to 50e, and primary air flows to the adjacent wind box 50 when there is a pressure

difference in the adjacent wind box 50), the pressure loss of the grate bar 41, the pressure loss of the garbage layer, and the pressure measured by the in-furnace pressure sensor 35.

In addition, a relationship is analyzed in advance between the pressure loss caused by the garbage layer and the garbage height. For example, a model, a calculation expression,

5 or the like that outputs the height of the garbage layer in view of the leak between the wind boxes when the flow rate of the primary air measured by the air flow rate sensor 76, the pressure measured by the first air pressure sensor 77, the opening degrees of the primary air dampers 75a to 75e, and the pressure measured by the in-furnace pressure sensor 35 are input is prepared. During the operation of the combustion facility 1, the

10 height acquisition unit 2a acquires the pressure measured by the first air pressure sensor 77, the opening degrees of the primary air dampers 75a to 75e, and the pressure measured by the in-furnace pressure sensor 35, and estimates the height of the garbage layer based on the pressure loss from the model or the calculation expression prepared in advance.

For example, the weighted sum of the estimated garbage layer height is calculated, based

15 on the garbage layer height estimated based on the image and the pressure loss. In this manner, the garbage layer height estimated from the image is corrected by using the garbage height estimated from the pressure loss.

[0042]

In this way, since the configuration is adopted in view of the leak between the

20 wind boxes, the operation of the adjacent primary air damper does not affect the estimation of the garbage layer height, and estimation accuracy of the garbage layer height can be improved. In a case of modeling the garbage layer height caused by the pressure loss, transmittance of the garbage (how much the primary air passes through the garbage) has a relationship with the pressure loss, and the transmittance of the garbage
25 varies depending on the garbage. Therefore, the height of the garbage layer may be

estimated from the transmittance of the garbage and the pressure loss of the garbage layer. In this case, the garbage layer height may be estimated by assuming that the transmittance of the garbage has a correlation with a prediction value of the LHV (to be described later) and in view of the transmittance. Alternatively, a change in the transmittance may be represented as a moving average, and a ratio of a moving average value of the transmittance to the transmittance of a current value may be taken. In this manner, the garbage layer height may be estimated by reducing the influence of the change in the transmittance. Alternatively, the transmittance of the garbage may be estimated by estimating the garbage layer height with the infrared camera 133 and comparing the garbage layer height with the layer height caused by the pressure loss. A differential value of the garbage layer height may be acquired to be used as an index value indicating a tendency of the change in the garbage layer height. Since the garbage height is estimated, when the combustion deteriorates even though the garbage is loaded and the garbage layer relatively becomes higher, it can be considered that the low-quality garbage is loaded, and the garbage height can be used as a detection end for the low-quality garbage. In addition, since this configuration is combined with the LHV (to be described later), it can be estimated that the combustion deterioration results from loading of the low-quality garbage.

[0043]

The LHV acquisition unit 2b acquires in advance the LHV of the garbage before the garbage is loaded into the furnace. For example, the LHV acquisition unit 2b acquires the LHV of the garbage measured by the LHV measuring instrument 23. The garbage of the hopper 21 has a time margin of 20 to 30 minutes until the garbage is loaded into the furnace after the LHV is measured, and combustion control is performed, based on the LHV measured by the LHV measuring instrument 23. In this manner, it is

possible to prepare a facility (for example, the air preheater 73) having a response delay of control. In addition, the LHV acquisition unit 2b may predict the LHV of the garbage by using an LHV soft sensor. For example, the LHV acquisition unit 2b acquires the pressure measured by the in-furnace pressure sensor 35, the temperature measured by the in-furnace temperature sensor 31, the boiler drum level of the heat recovery steam generator 4, a gas flow rate measured by the flow rate sensor 37, and a steam flow rate measured by the flow rate sensor 38, and constructs a learning model trained to learn a relationship between the acquired data and the measurement value of the LHV of the garbage, through deep learning or the like. This learning model will be referred to as an LHV soft sensor. During the operation of the combustion facility 1, the LHV acquisition unit 2b acquires the pressure measured by the in-furnace pressure sensor 35, the temperature measured by the in-furnace temperature sensor 31, the boiler drum level of the heat recovery steam generator 4, the gas flow rate measured by the flow rate sensor 37, and the steam flow rate measured by the flow rate sensor 38, and inputs the acquired data to the LHV soft sensor to acquire a prediction value of the LHV. Through the verification by the applicant, it is confirmed that the LHV of the garbage inside the furnace in the future (for example, approximately 10 minutes later) can be predicted by the LHV soft sensor. In addition, the LHV may be predicted by calculating density of the garbage in the bottom portion of the hopper 21, or the density of the garbage in the bottom portion of the hopper 21 may be added to a parameter input to the LHV soft sensor. In this way, the LHV is detected in advance by the LHV measuring instrument 23 or the LHV soft sensor before the garbage is loaded into the furnace. In this manner, the furnace interior can be prepared in a combustion promoting state (for example, the primary air is warmed by the air preheater 73 having slow responsiveness) until the garbage is loaded into the furnace. Instead of the average

value of the LHV when a crane is loaded (predicting the LHV with a weight and a volume of the crane) or a state quantity of the upper layer portion of the hopper 21 (for example, evaluating the moisture content with the infrared camera) which is performed in the related art, the LHV of the garbage after juice extraction in the bottom portion of the hopper 21 or the future LHV prediction value obtained by the LHV soft sensor is detected from time to time. In this manner, a control value inside the furnace can be determined in detail.

[0044]

The O₂ concentration acquisition unit 2c acquires O₂ concentration inside the furnace. For example, the O₂ concentration acquisition unit 2c acquires the image captured by the visible light camera 32, the pressure measured by the in-furnace pressure sensor 35, the temperature measured by the in-furnace temperature sensor 31, the steam flow rate measured by the flow rate sensor 37, and the concentration of the gas component containing O₂ detected by the gas sensor 81, and constructs a learning model trained to learn a relationship between the acquired image, the pressure, the temperature, and steam flow rate, and the O₂ concentration, through the deep learning or the like. This learning model will be referred to as an O₂ soft sensor. During the operation of the combustion facility 1, the O₂ concentration acquisition unit 2c acquires the image captured by the visible light camera 32, the pressure measured by the in-furnace pressure sensor 35, the temperature measured by the in-furnace temperature sensor 31, and the steam flow rate measured by the flow rate sensor 37, and inputs the acquired data to the O₂ soft sensor to predict the O₂ concentration. Since the O₂ soft sensor is used, the O₂ concentration subsequent to the outlet of the furnace body 30 can be predicted in advance. The O₂ soft sensor is used to detect the shortage of garbage. When O₂ increases, it is regarded that the combustion deteriorates. In this manner, it is possible

to detect the shortage of garbage in advance.

[0045]

The combustion determination unit 2d evaluates a combustion state of the garbage, and when the combustion is deteriorated, the combustion determination unit 2d determines whether the combustion deterioration is caused by (1) shortage of garbage (insufficient garbage), (2) low-quality garbage (garbage having a low LHV, garbage which is less likely to burn such as garbage having high moisture, or (3) other reasons.

When the height of the garbage layer estimated by the height acquisition unit 2a is smaller than a threshold value and the O₂ concentration estimated by the O₂

concentration acquisition unit 2c is greater than a threshold value, the combustion determination unit 2d determines that combustion deterioration occurs (1) due to the shortage of garbage. In addition, when the LHV estimated by the LHV acquisition unit 2b is smaller than the threshold value, the combustion determination unit 2d predicts that combustion deterioration occurs (2) due to the low-quality garbage. In addition, when the O₂ concentration estimated by the O₂ concentration acquisition unit 2c increases, the temperature measured by the furnace outlet-side temperature sensor 36 is lowered, and the steam flow rate measured by the flow rate sensor 37 is lowered, the combustion determination unit 2d determines that the combustion is deteriorated (3) due to other reasons.

[0046]

The control unit 2e performs control for the opening degrees of the primary air dampers 75a to 75e, control for the reciprocating operation of the movable grate bar 41a, control for a stroke length and a speed (feed rate) of the feeder 22, and the like. When the opening degrees of the primary air dampers 75a to 75e increase, the supply amount of the primary air increases, and the combustion of the garbage is promoted. When the

reciprocating operation of the movable grate bar 41a is accelerated, the garbage is stirred and the combustion is promoted. However, when the acceleration is continued, a large amount of the garbage is transported without being combusted, and non-combusted garbage is generated. When the stroke length of the feeder 22 increases or the feed rate increases, the combustion is promoted unless the property of the garbage is low-quality garbage. However, when the amount of the garbage to be loaded into the furnace is too large, the non-combusted garbage is generated. The control unit 2e performs control according to the reasons of the combustion deterioration, based on the determination of the combustion determination unit 2d.

10 [0047]

For example, (1) when it is determined that the combustion deterioration results from the shortage of garbage, the control unit 2e increases the supply amount of the garbage by increasing the stroke length and raising the feed rate of the feeder 22. In this manner, the combustion deterioration can be suppressed, and an evaporation flow rate can be stabilized. In addition, since the feeder 22 is operated at a high speed, an inertial force is improved, and the garbage loading is promoted. Accordingly, it is possible to avoid a phenomenon of empty striking in which the garbage is not loaded even when the garbage is pushed. How much the stroke length is increased and how much the feed rate is raised may be determined as LHV matching. In this manner, it is possible to prevent a large amount of low LHV garbage (low-quality garbage) from being erroneously supplied. In addition, in order to avoid excessive supply of the garbage, the control for increasing the stroke length and the feed rate of the feeder 22 may be limited to a period during which the feeder 22 pushes the garbage once or twice. In this manner, a minimum required amount of the garbage can be combusted, and an operation can be performed on a small processing amount of the garbage.

[0048]

For example, (2) when it is determined that the combustion deterioration results from the low-quality garbage, the control unit 2e reduces or temporarily stops the feed rate of the feeder 22 such that the garbage is not excessively loaded. In addition, the control unit 2e drives the air preheater 73 in a control delay by causing the LHV measuring instrument 23 or the LHV soft sensor to predict the quality deterioration of the garbage in advance, and starts to raise the temperature of the primary air before the garbage is loaded. When the garbage is loaded, the opening degree of the primary air damper 75a on the most upstream side is increased, and the supply amount of the primary air having the raised temperature is increased. In addition, the control unit 2e accelerates the reciprocating operation of the grate bar 41 for a short time to stir the garbage layer and to promote the combustion. This control is different from the control in the related art for the purpose of increasing the transport speed of the garbage to reduce a retention time or the garbage layer height. This control is performed for the purpose of promoting the combustion by strengthening contact between previously burning garbage and garbage which is not yet burning by stirring the garbage. The control unit 2e temporarily rapidly increases the speed of the movable grate bar 41a and causes the movable grate bar 41a to reciprocate to such an extent that an average transport speed of the garbage transported by the stoker 40 does not increase. In this manner, when the garbage dried on a lower layer is rapidly fed to a surface layer, the garbage is fed to the surface layer before the moisture is transferred from the garbage containing moisture on an intermediate layer to the garbage dried on the lower layer. On the surface layer, the garbage is warmed by emitted heat from the flame, and ignites the garbage when the garbage is dried. Therefore, the combustion can be promoted. In addition, since the ignited and combusted garbage is fed to the intermediate layer

before being completely burned, a combustion promoting effect can be obtained. For this purpose, it is important to stir the garbage layer at a high speed. In addition, in order to prevent an increase in the average transport speed of the garbage, for example, when the movable grate bar 41a is operated at a high speed for 2 to 3 minutes, the operation for stopping the movable grate bar 41a for 3 to 4 minutes thereafter is repeatedly performed, and the average transport speed is adjusted to have a desired value. In addition, when the movable grate bar 41a regularly and continuously reciprocates while maintaining a high speed, the garbage is excessively combusted in this case, and the non-combusted portion (CO) on a gas phase side increases. In order to prevent this problem, in the present embodiment, the ignition is regarded as the recovery of the evaporation flow rate, and the control for rapidly increasing the speed of the movable grate bar 41a is not performed when the evaporation flow rate is recovered. In this manner, it is possible to stably perform an automatic operation even in a furnace having a great penalty in the generation of the non-combusted portion (CO).

[0049]

Next, a flow of garbage combustion inside the furnace will be described with reference to FIGS. 4A and 4B. FIG. 4A shows a flow of the garbage combustion when normal garbage that does not have low quality is loaded. FIG. 4A(a) shows a state of garbage loading. FIG. 4A(b) shows a state before the garbage is ignited. FIG. 4A(c) shows a state where the garbage is ignited after being stirred by the stoker 40. In some cases, the garbage is ignited before being stirred by the stoker 40. In a case of the normal garbage, (a) to (c) are repeated, and stable combustion and a stable steam flow rate can be ensured. When the combustion determination unit 2d determines (1) the shortage of garbage, the stable combustion can be continued by increasing the feed rate under the control for the feeder 22.

[0050]

FIG. 4B shows a flow of the garbage combustion when the low-quality garbage is loaded. First, the control in the related art will be described. FIG. 4B(a) shows a state of garbage loading. FIG. 4B(b) shows a state where misfire occurs in the low-quality garbage before ignition. FIG. 4B(c) shows a state where the garbage is dried after being stirred by the stoker 40. FIG. 4B(d) shows a state where the garbage is ignited. For example, in a case of the control in the related art in which the supply amount of the garbage is determined in terms of the evaporation flow rate matching, when a decrease in the steam flow rate is observed due to an ignition delay in FIG. 4B(b), there is a possibility that the steam flow rate is unnecessarily decreased by repeating (a) and (b) in view of the fact that the garbage is insufficient.

[0051]

In contrast, according to the present embodiment, the prediction value of the LHV is acquired before FIG. 4B(a) to predict the loading of the low-quality garbage, and the speed of the reciprocating operation of the movable grate bar 41a is rapidly increased while the feeder 22 is decelerated. Furthermore, the combustion air temperature is raised and the supply amount is increased to promote the combustion by controlling the air preheater 73 to warm the primary air and to increase the opening degree of the primary air damper 75a on the most upstream side. In this manner, the low-quality garbage can also be stably combusted. In the control in the related art, in a case of the garbage containing a large amount of moisture, the control is often performed such that the speed of the stoker 40 is reduced and the garbage is slowly combusted. However, in the present embodiment, the garbage is stirred and the combustion is promoted by rapidly increasing the speed of the stoker 40 (speed of the reciprocating operation of the movable grate bar 41a).

[0052]

(Operation)

FIG. 5 is a flowchart showing an example of combustion control according to the embodiment.

5 As a premise, the following is assumed. The height acquisition unit 2a estimates the height of the garbage layer from the image captured by the infrared camera 33, and corrects the height to the garbage layer height based on the pressure loss of the garbage layer in view of the leak between the wind boxes. In this manner, in parallel with the following Steps S1 to S6a, processing in which the garbage layer height is
10 acquired, processing in which the LHV acquisition unit 2b acquires the LHV of the garbage measured by the LHV measuring instrument 23 before the garbage is loaded into the furnace and/or the prediction value of the LHV inside the furnace after 10 minutes by using the LHV soft sensor, processing in which the O₂ concentration acquisition unit 2c acquires the O₂ concentration inside the furnace by the O₂ soft sensor, and processing in
15 which the control device 2 acquires the measurement values from various sensors provided in the combustion facility 1 are repeatedly performed at each processing cycle. In addition, the processing in Steps S1 to S6 below is also repeatedly performed at a predetermined control cycle while the combustion facility 1 is operated.

[0053]

20 The combustion determination unit 2d determines whether or not a shortage of garbage is occurring (Step S1). Specifically, the combustion determination unit 2d determines that the shortage of garbage is occurred when the height of the garbage layer which is acquired by the height acquisition unit 2a is smaller than a predetermined threshold value and the O₂ concentration inside the furnace which is acquired by the O₂
25 concentration acquisition unit 2c is equal to or greater than a predetermined threshold

value. When these conditions are not satisfied, the combustion determination unit 2d determines that the shortage of garbage is not occurred. When it is determined that the shortage of garbage is not occurred (Step S1; No), the process proceeds to Step S3.

When it is determined that the shortage of garbage is occurred (Step S1; Yes), the control unit 2e increases the feed rate of the feeder 22, and increases the stroke length of the feeder 22 (Step S2). In this manner, the supply amount of the garbage into the furnace increases, and the shortage of garbage can be eliminated.

[0054]

Next, the combustion determination unit 2d determines whether or not the low-quality garbage is loaded (Step S3). Specifically, when the LHV acquired by the LHV acquisition unit 2b is smaller than the threshold value, the combustion determination unit 2d determines that the low-quality garbage is loaded, and when the LHV acquired by the LHV acquisition unit 2b is not smaller than the threshold value, the combustion determination unit 2d determines that the low-quality garbage is not loaded. When it is determined that the low-quality garbage is not loaded (Step S3; No), the processing proceeds to Step S5. When it is determined that the low-quality garbage is loaded (Step S3; Yes), the control unit 2e controls the air preheater 73 to raise the temperature of the primary air to a predetermined temperature. When the temperature of the primary air is raised to a predetermined temperature or a predetermined time elapses after the LHV acquisition unit 2b acquires a value of the LHV value that indicates the low-quality garbage (for example, in a case of the LHV soft sensor, after 10 minutes, in a case of the LHV measuring instrument 23, after 20 minutes, and the like), the control unit 2e starts a control for increasing the opening degree of the primary air damper 75a on the most upstream side by a predetermined value, increasing the supply amount of the primary air supplied to the garbage immediately after the garbage is loaded into the furnace,

decreasing the feed rate of the feeder 22 to a predetermined rate, and further, rapidly increasing the speed of the stoker 40 for a short time. In this manner, the stirring and the combustion of the low-quality garbage are promoted, and the combustion deterioration resulting from the low-quality garbage can be prevented in advance.

5 [0055]

Next, the combustion determination unit 2d determines whether or not the combustion is deteriorated due to other reasons (Step S5). Specifically, when the O₂ concentration acquired by the O₂ concentration acquisition unit 2c is equal to or greater than a threshold value, the temperature measured by the furnace outlet-side temperature
10 sensor 36 is smaller than a threshold value, and the steam flow rate measured by the flow rate sensor 38 is smaller than a threshold value, the combustion determination unit 2d determines that the combustion is deteriorated, and when these conditions are not satisfied, the combustion determination unit 2d determines that the combustion is not deteriorated. When it is determined that the combustion is not deteriorated (Step S5;
15 No), a flowchart in FIG. 5 ends. When it is determined that the combustion is deteriorated (Step S5; Yes), the control unit 2e performs control for rapidly increasing the speed of the stoker 40 for a short time, stirring the garbage, and promoting the combustion. It is confirmed that the combustion deterioration can be avoided or the combustion deterioration can be quickly (instantaneously) recovered by these controls.

20 [0056]

The control shown in FIG. 5 is an example. For example, the order of performing Steps S1 and S2 and Steps S3 and S4 may be reversed. In addition, in the determination of the shortage of garbage in Step S1, the condition that the garbage layer height is smaller than the threshold value is set, but the shortage of garbage may be
25 present even when a loading heat amount and the garbage layer height are kept constant.

The reason is as follows. The height of the garbage layer depends on how easy the garbage is completely burned. Therefore, the height of the garbage layer may be maintained in a case of the garbage which is less likely to completely burn. Therefore, the threshold value of the garbage layer height may be set to a value which can determine the shortage of garbage without exception even in this case, and the determination in Step S1 may be performed. In addition, in the determination in Step S1, when the O₂ concentration inside the furnace is equal to or greater than the predetermined threshold value without considering the garbage layer height, it may be determined that the shortage of garbage is present. In addition, in Step S1, the O₂ concentration is compared with the threshold value. However, the increase rate of the O₂ concentration may be compared with the threshold value instead of or in addition to the O₂ concentration, and the insufficient shortage of garbage may be determined when the increase rate is equal to or greater than the threshold value.

[0057]

(Advantageous Effects)

As described above, according to the present embodiment, the combustion can be stabilized by detecting a sign of the combustion deterioration inside the furnace in advance. Regarding the reasons of the combustion deterioration, in the control in the related art, the combustion deterioration is often detected by using the steam flow rate, the temperature, and the O₂ concentration as indicators, but when only these indicators are used, the same trend is indicated regardless of the reasons. Consequently, it is difficult to discriminate the reasons of the combustion deterioration. In contrast, in the present embodiment, the cause of the combustion deterioration can be determined by combining the garbage layer height obtained from the pressure loss between the wind box 50 and the furnace interior, an antecedent prediction value of the LHV measured by

the LHV measuring instrument 23 and/or the LHV soft sensor of the bottom portion of the hopper 21 (not after the garbage is loaded), and antecedent O₂ concentration measured by the O₂ soft sensor. In this manner, it is possible to distinguish and determine whether the reason of the combustion deterioration is (1) the shortage of garbage or (2) the low-quality garbage, and it is possible to take proper measures according to the reasons (in a case of the shortage of garbage, the garbage is loaded, and in a case where the low-quality garbage is loaded, ignition is promoted). In addition, when the combustion of the garbage is promoted, the garbage can be stirred and the combustion of the garbage can be promoted by temporarily rapidly increasing the speed of the stoker 40 (reciprocating speed of the movable grate bar 41a).

[0058]

FIG. 6 is a diagram showing an example of a hardware configuration of the control device. A computer 900 includes a CPU 901, a main storage device 902, an auxiliary storage device 903, an input/output interface 904, and a communication interface 905. The control device 2 described above is installed in the computer 900. In addition, each function described above is stored in the auxiliary storage device 903 in a form of a program. The CPU 901 reads the program from the auxiliary storage device 903, deploys the program in the main storage device 902, and performs the above-described processing according to the program. In addition, the CPU 901 secures a storage area in the main storage device 902 according to the program. The CPU 901 secures a storage area for storing data being processed in the auxiliary storage device 903 according to the program.

[0059]

Processing of each functional unit may be performed by recording a program for realizing all or some of the functions of the control device 2 on a computer-readable

recording medium, and causing the computer system to read and execute the program recorded on the recording medium. Here, it is assumed that the "computer system" described here includes an OS and hardware such as a peripheral device. In addition, the "computer system" includes a homepage providing environment (or a display environment) when a WWW system is used. The "computer-readable recording medium" refers to a portable medium, such as a CD, a DVD, or a USB, or a storage device, such as a hard disk drive incorporated in the computer system. In addition, when this program is distributed to the computer 900 via a communication line, the computer 900 receiving the distribution may deploy the program in the main storage device 902, and may perform the above-described processing. In addition, the program may realize some of the above-described functions, and, furthermore, may be capable of realizing the above-described functions in combination with the program previously recorded in the computer system.

[0060]

While preferred embodiments of the invention have been described and illustrated above, it should be understood that these are exemplary examples of the invention and are not to be considered as limiting. Additions, omissions, substitutions, and other modifications can be made without departing from the scope of the invention. Accordingly, the invention is not to be considered as being limited by the foregoing description and is only limited by the scope of the appended claims.

[0061]

<Appendix>

The control device and the control method according to the embodiment are understood as follows, for example.

[0062]

(1) According to a first aspect, there is provided a control device of a garbage incineration facility. The control device includes a height acquisition unit configured to acquire a garbage layer height inside a furnace, an LHV acquisition unit configured to acquire an LHV of garbage to be loaded into the furnace before the garbage is loaded, an
5 O₂ concentration acquisition unit configured to acquire an oxygen concentration inside the furnace, a determination unit configured to determine combustion deterioration by distinguishing between combustion deterioration resulting from shortage of garbage and combustion deterioration resulting from loading of garbage which is less likely to burn, by using the garbage layer height, the LHV, and the oxygen concentration, and a control
10 unit configured to perform control for increasing a supply amount of the garbage when it is determined that the combustion deterioration results from the shortage of garbage, and configured to perform control for promoting combustion of the garbage when it is determined that the combustion deterioration results from the loading of the garbage which is less likely to burn.

15 In this manner, it is possible to distinguish and determine between combustion deterioration resulting from shortage of garbage and combustion deterioration resulting from loading of the garbage which is less likely to burn.

[0063]

(2) As the control device according to a second aspect, in the control device
20 according to (1) to (2), the determination unit determines that the combustion deterioration results from the shortage of garbage when the garbage layer height is smaller than a threshold value and the oxygen concentration is equal to or greater than a threshold value, and determines that the combustion deterioration results from the loading of the garbage which is less likely to burn when the LHV is smaller than a
25 threshold value.

In this manner, it is possible to distinguish and determine between combustion deterioration resulting from shortage of garbage and combustion deterioration resulting from loading of the garbage which is less likely to burn.

[0064]

5 (3) As the control device according to a third aspect, in the control device according to (1) to (2), the LHV acquisition unit acquires an LHV of garbage measured by an LHV measuring instrument provided in a bottom portion of a hopper included in the incineration facility, or acquires an LHV predicted by a prediction model for predicting the LHV inside the furnace at a predetermined future time.

10 In this manner, the LHV of the garbage before the garbage is loaded can be acquired.

[0065]

 (4) As the control device according to a fourth aspect, in the control device according to (1) to (3), the control unit temporarily rapidly increases a speed of a
15 reciprocating operation of a grate bar forming a stoker included in the combustion facility to stir the garbage, and promotes the combustion of the garbage by stirring the garbage.

In this manner, the low-quality garbage can be stirred to promote the combustion.

[0066]

20 (5) As the control device according to a fifth aspect, in the control device according to any one of (1) to (4), the height acquisition unit estimates the height of the garbage layer, based on a relationship between the height of the garbage layer laminated on the stoker inside the furnace of the combustion facility and the pressure loss of
primary air which is caused by the garbage layer of the primary air supplied from a lower
25 portion of the stoker toward the garbage layer, a measurement value of the pressure of

the primary air in the lower portion of the stoker, and a measurement value of the pressure in an upper portion of the garbage layer, and the relationship is analyzed in view of a fact that the primary air supplied from the lower portion of the stoker leaks to outward of the garbage layer.

5 In this manner, the height of the garbage layer can be estimated in view of the leak between the wind boxes.

[0067]

(6) According to a sixth aspect, there is provided a control method for a garbage combustion facility. The control method includes acquiring a garbage layer height
10 inside a furnace, acquiring an LHV of garbage to be loaded into the furnace before the garbage is loaded, acquiring an oxygen concentration inside the furnace, determining combustion deterioration by distinguishing between combustion deterioration resulting from the shortage of garbage and combustion deterioration resulting from loading of garbage which is less likely to burn, by using the garbage layer height, the LHV, and the
15 oxygen concentration, and performing control for increasing a supply amount of the garbage when it is determined that the combustion deterioration results from the shortage of garbage, and performing control for promoting combustion of the garbage when it is determined that the combustion deterioration results from the loading of the garbage which is less likely to burn.

20

EXPLANATION OF REFERENCES

[0068]

1: Combustion facility

2: Control device

25 2a: Height acquisition unit

	2b: LHV acquisition unit
	2c: O ₂ concentration acquisition unit
	2d: Combustion determination unit
	2e: Control unit
5	3: Incinerator
	21: Hopper
	22: Feeder
	23: LHV measuring instrument
	24: Sprinkling device
10	30: Furnace body
	31: In-furnace temperature sensor
	32: Visible light camera
	33: Infrared camera
	35: In-furnace pressure sensor
15	36: Furnace outlet-side temperature sensor
	37, 38: Flow rate sensor
	40: Stoker
	41: Grate bar
	50: Wind box
20	51: Wind box pressure sensor
	55: Front ceiling section
	57: Rear ceiling section
	59: Rear wall
	60: Furnace
25	60a: Front wall

	60b: Rear wall
	70: Blower mechanism
	71: Blower
	73: Air preheater
5	75: Damper
	81: Gas sensor
	91: First EGR nozzle
	93: Second EGR nozzle
	900: Computer
10	901: CPU
	902: Main storage device
	903: Auxiliary storage device
	904: Input/output interface
	905: Communication interface
15	

What is claimed is:

1. A control device of a garbage combustion facility, the control device comprising:

5 a height acquisition unit configured to acquire a garbage layer height inside a furnace;

an LHV acquisition unit configured to acquire an LHV of garbage to be loaded into the furnace before the garbage is loaded into the furnace;

an O₂ concentration acquisition unit configured to acquire an oxygen concentration inside the furnace;

10 a determination unit configured to determine combustion deterioration by distinguishing between combustion deterioration resulting from shortage of garbage and combustion deterioration resulting from loading of garbage which is less likely to burn, by using the garbage layer height, the LHV, and the oxygen concentration; and

a control unit configured to perform control for increasing a supply amount of the garbage when it is determined that the combustion deterioration results from the shortage of garbage, and configured to perform control for promoting combustion of the garbage when it is determined that the combustion deterioration results from the loading of the garbage which is less likely to burn.

20 2. The control device according to Claim 1,

wherein the determination unit determines that the combustion deterioration results from the shortage of garbage when the garbage layer height is smaller than a threshold value and the oxygen concentration is equal to or greater than a threshold value, and determines that the combustion deterioration results from the loading of the garbage which is less likely to burn when the LHV is smaller than a threshold value.

25

3. The control device according to Claim 1 or 2,

wherein the LHV acquisition unit acquires an LHV of garbage measured by an LHV measuring instrument provided in a bottom portion of a hopper included in the combustion facility, or acquires an LHV predicted by a prediction model for predicting the LHV inside the furnace at a predetermined future time.

4. The control device according to Claim 1 or 2,

wherein the control unit temporarily rapidly increases a speed of a reciprocating operation of a grate bar forming a stoker included in the combustion facility to stir the garbage, and promotes the combustion of the garbage by stirring the garbage.

5. A control method of a garbage combustion facility, the control method comprising:

acquiring a garbage layer height inside a furnace;

acquiring an LHV of garbage to be loaded into the furnace before the garbage is loaded into the furnace;

acquiring an oxygen concentration inside the furnace;

determining combustion deterioration by distinguishing between combustion deterioration resulting from shortage of garbage and combustion deterioration resulting from loading of garbage which is less likely to burn, by using the garbage layer height, the LHV, and the oxygen concentration; and

performing control for increasing a supply amount of the garbage when it is determined that the combustion deterioration results from the shortage of garbage, and performing control for promoting combustion of the garbage when it is determined that the combustion deterioration results from the loading of the garbage which is less likely

to burn.