

**INCINERATOR SUPPLY AMOUNT DETECTION SYSTEM, INCINERATOR
OPERATION CONTROL SYSTEM, INCINERATOR SUPPLY AMOUNT
DETECTION METHOD, AND INCINERATOR OPERATION CONTROL METHOD**

5 TECHNICAL FIELD

[0001] The present disclosure relates to an incinerator supply amount detection system, an incinerator operation control system, an incinerator supply amount detection method, and an incinerator operation control method.

10 BACKGROUND

[0002] For example, as disclosed in Patent Documents 1 to 3, an incinerator includes a combustion chamber capable of burning solid fuel (e.g., dust or biomass), and a fuel supply device for supplying the solid fuel to the combustion chamber.

15 Citation List

Patent Literature

[0003]

Patent Document 1: JP2019-132485A

Patent Document 2: JP2017-116252A

20 Patent Document 3: JP2003-161422A

SUMMARY

Problems to be Solved

[0004] In order to stabilize the combustion state of solid fuel in the combustion chamber,
25 for example, the fuel supply device may be configured to adjust the amount of the solid fuel supplied to the combustion chamber and the supply timing. However, solid fuels often have heterogeneous properties, and solid fuels may entangle or adhere to each other, resulting in clumping. The clumped solid fuel may not fall down but protrude into the combustion

chamber even when the fuel supply device is operated. The clumped solid fuel may collapse at unintended times, causing a phenomenon in which a large amount of solid fuel is supplied to the combustion chamber at one time (hereinafter, referred to as oversupply). If the oversupply occurs, the combustion state of solid fuel in the combustion chamber becomes unstable, so it is necessary to quickly perform an operation to stabilize the combustion state. For this reason, it is desirable to quickly detect the occurrence of oversupply.

[0005] The present disclosure was made in view of the above problems, and an object thereof is to provide an incinerator supply amount detection system that can quickly detect the oversupply of solid fuel to a combustion chamber, an incinerator operation control system including this supply amount detection system, an incinerator supply amount detection method, and an incinerator operation control method including this supply amount detection method.

Solution to the Problems

[0006] To achieve the above object, an incinerator supply amount detection system according to the present disclosure for detecting the amount of solid fuel supplied to a combustion chamber of an incinerator includes: an imaging device configured to capture an image of the solid fuel before the solid fuel deposited in a feeder part of the incinerator falls into the combustion chamber; and a detection device configured to detect the amount of the solid fuel supplied to the combustion chamber, based on the image captured by the imaging device.

Advantageous Effects

[0007] With the supply amount detection system of the present disclosure, it is possible to quickly detect the oversupply of solid fuel to a combustion chamber.

BRIEF DESCRIPTION OF DRAWINGS

[0008] FIG. 1 is a schematic configuration diagram of an incinerator to which the supply amount detection system according to the first embodiment of the present disclosure is applied.

FIG. 2 is a schematic configuration diagram of the captured image according to another embodiment of the present disclosure.

FIG. 3 is a schematic functional block diagram of the detection device according to the first embodiment of the present disclosure.

5 FIG. 4 is a diagram showing an example of the thermal image of the front surface of the solid fuel immediately after the occurrence of oversupply.

FIG. 5 is a diagram showing an example of the thermal image of the front surface of the solid fuel immediately before the occurrence of oversupply.

10 FIG. 6 is a graph showing the luminance of the thermal image of the front surface of the solid fuel before falling into the combustion chamber.

FIG. 7 is a schematic functional block diagram of the detection device according to the second embodiment of the present disclosure.

FIG. 8 is an explanatory diagram for describing the function of the dividing unit according to the second embodiment of the present disclosure.

15 FIG. 9 is a schematic configuration diagram of the supply amount detection system according to the third embodiment of the present disclosure.

FIG. 10 is a schematic configuration diagram of the flame position detection device according to the third embodiment of the present disclosure.

20 FIG. 11 is a diagram showing an example of a binarized image of flame generated inside the combustion chamber.

FIG. 12 is a graph showing the difference in flame position when the oversupply occurs.

FIG. 13 is an explanatory diagram for describing the operation of the protruding length detection device and the height detection device according to the third embodiment of the present disclosure.

25 FIG. 14 is a schematic configuration diagram of the operation control system according to the fourth embodiment of the present disclosure.

FIG. 15 is a schematic functional block diagram of the operation control device according to the fourth embodiment of the present disclosure.

FIG. 16 is a diagram showing an example of an operation map.

FIG. 17 is a diagram showing an example of an additional operation map.

FIG. 18 is a flowchart of the incinerator supply amount detection method according to an embodiment of the present disclosure.

5 FIG. 19 is a flowchart of the flow of the determination step according to an embodiment of the present disclosure.

FIG. 20 is a flowchart of the incinerator operation control method according to an embodiment of the present disclosure.

10 FIG. 21 is a flowchart of the flow of the flow rate regulating step according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0009] Hereinafter, an incinerator supply amount detection system, an incinerator operation control system including this supply amount detection system, an incinerator supply amount
15 detection method, and an incinerator operation control method including this supply amount detection method according to embodiments of the present disclosure will be described based on the drawings. The following embodiments are illustrative and not intended to limit the present disclosure, and various modifications are possible within the scope of technical ideas of the present disclosure.

20 [0010] <First Embodiment>
(Configuration of incinerator)

FIG. 1 is a schematic configuration diagram of an incinerator 100 to which the supply amount detection system 1 according to the first embodiment of the present disclosure is applied. In the embodiment illustrated in FIG. 1, the incinerator 100 is a stoker-type waste incinerator
25 which uses solid fuel Fg such as municipal waste, industrial waste, or biomass. However, the incinerator 100 is not limited to a stoker-type waste incinerator.

[0011] As shown in FIG. 1, the incinerator 100 includes a hopper 102, a feeder part 104, a combustion chamber 108, a pushing device 110 (refuse feeding device), an air supply device

112, a heat recovery steam generator 114, a cooling tower 116, a dust collection device 118, and a stack 120.

[0012] The feeder part 104 is a passage extending toward the combustion chamber 108. The feeder part 104 is configured to receive the solid fuel Fg put into the hopper 102. When the direction in which the solid fuel Fg moves in the incinerator 100 is referred to as the moving direction W1, a downstream end 121 of the feeder part 104 on the downstream side in the moving direction W1 (the end of the feeder part 104 adjacent to the combustion chamber 108) is connected to an inlet 122 of the combustion chamber 108.

[0013] The pushing device 110 has a pushing arm 124 for pushing out the solid fuel Fg deposited in the feeder part 104 into the combustion chamber 108 through the inlet 122. The pushing arm 124 is configured to be movable within the feeder part 104 from upstream to downstream and from downstream to upstream in the moving direction W1. That is, the pushing arm 124 reciprocates within the feeder part 104 in the extension direction (horizontal direction) of the feeder part 104.

[0014] The combustion chamber 108 includes a grate 126 (stoker) on which the solid fuel Fg pushed into the combustion chamber 108 through the inlet 122 falls. The grate 126 corresponds to the floor portion of the combustion chamber 108. The grate 126 is configured to move the solid fuel Fg on the grate 126 in a direction away from the inlet 122 (from upstream to downstream in the moving direction W1). Further, the combustion chamber 108 includes a drying region 128, a combustion region 130, and a post-combustion region 132, which are arranged in order from upstream to downstream in the moving direction W1. In the drying region 128, the solid fuel Fg is dried by heat in the combustion chamber 108. In the combustion region 130, the solid fuel Fg is combusted with a flame 131. In the post-combustion region 132, unburnt fuel in the combustion region 130 is completely combusted. The solid fuel Fg that has been dried, combusted, and post-combusted in the combustion chamber 108 becomes ash Fa and is discharged out of the incinerator 100.

[0015] The air supply device 112 is configured to supply the combustion chamber 108 with primary air used for combusting the solid fuel Fg and secondary air used for reducing the

concentration of unburned gas such as carbon monoxide generated by combustion of the solid fuel Fg. In the exemplary embodiment illustrated in FIG. 1, the air supply device 112 includes an air supply pipe 136 and a blower 138 disposed in the air supply pipe 136. Part of the air flowing through the air supply pipe 136 is supplied as the primary air from the grate 126 to a lower portion of the combustion chamber 108 via a first flow rate regulating valve 140, and the remainder is supplied as the secondary air from a side wall of the combustion chamber 108 to an upper portion of the combustion chamber 108 via a second flow rate regulating valve 142. The air supply device 112 functions as a secondary air supply device for supplying the secondary air to the upper portion of the combustion chamber 108. In the exemplary embodiment illustrated in FIG. 1, the primary air is supplied to each of the drying region 128, the combustion region 130, and the post-combustion region 132 of the combustion chamber 108.

[0016] Each of the heat recovery steam generator 114, the cooling tower 116, the dust collection device 118, and the stack 120 is provided in a gas duct 144 of the incinerator 100 through which exhaust gas 143 produced by combustion of the solid fuel Fg flows. The exhaust gas 143 flows through the heat recovery steam generator 114, the cooling tower 116, the dust collection device 118, and the stack 120 in this order. The heat recovery steam generator 114 generates steam from thermal energy of the exhaust gas 143. The cooling tower 116 lowers the temperature of the exhaust gas 143 having passed through the heat recovery steam generator 114. The dust collection device 118 collects fly ash contained in the exhaust gas 143 having passed through the cooling tower 116. Through the stack 120, the exhaust gas 143 having passed through the dust collection device 118 is discharged to the outside of the incinerator 100. The steam generated by the heat recovery steam generator 114 may be supplied to a steam turbine (not shown).

[0017] (Configuration of supply amount detection system)

The supply amount detection system 1 applied to the above-described incinerator 100 detects the amount of the solid fuel Fg supplied to the combustion chamber 108. As shown in FIG. 1, the supply amount detection system 1 includes an imaging device 2 and a detection

device 4.

[0018] The imaging device 2 is configured to capture a thermal image of the solid fuel Fg before the solid fuel Fg deposited in the feeder part 104 of the incinerator 100 falls into the combustion chamber 108. The thermal image of the solid fuel Fg captured by the imaging device 2 is sent to the detection device 4 in real time. In the exemplary embodiment shown in FIG. 1, the imaging device 2 is disposed at a furnace outlet 145 of the combustion chamber 108 downstream of the post-combustion region 132 of the combustion chamber 108 in the moving direction W1 so as to capture a thermal image of the front surface Fr, facing the combustion chamber 108, of surfaces of the solid fuel Fg before falling into the combustion chamber 108.

The imaging device 2 can capture a thermal image of the front surface Fr of the solid fuel Fg protruding from the inlet 122 of the combustion chamber 108. The imaging device 2 may be disposed at a location other than the furnace outlet 145 of the combustion chamber 108 as long as the thermal image of the front surface Fr of the solid fuel Fg can be captured.

[0019] The imaging device 2 is, for example, an infrared camera which detects infrared radiation in a predetermined wavelength range with little radiation from the flame 131. In this case, the predetermined wavelength range is, for example, between 2 μm and 5 μm . In order to capture a thermal image of the front surface Fr of the solid fuel Fg while suppressing the influence of the flame 131, the predetermined wavelength range is between 3.8 μm to 4.2 μm . The wavelength range to be imaged as the thermal image is 0.8 μm to 1000 μm . By applying a band-pass filter or the like for this wavelength range, only partial wavelengths can be used as necessary.

[0020] The imaging device 2 is not limited to an infrared camera as long as it can take a thermal image of the front surface Fr of the solid fuel Fg over the flame 131. In some embodiments, as shown in FIG. 2, the imaging device 2 includes a visible light camera 6 and a filter device 8 that limits transmission wavelengths incident on the visible light camera 6 to a predetermined wavelength range.

[0021] The detection device 4 detects the amount of the solid fuel Fg supplied to the combustion chamber 108, based on time transition of luminance information of the thermal

image captured by the imaging device 2. More specifically, the detection device 4 detects the amount of the solid fuel Fg supplied to the combustion chamber 108, based on the change amount of luminance information in time transition of luminance information of the thermal image captured by the imaging device 2. FIG. 3 is a schematic functional block diagram of the detection device 4 according to the first embodiment of the present disclosure.

[0022] As shown in FIG. 3, the detection device 4 includes a thermal image acquisition unit 10, a luminance information output unit 12, a storage unit 14, and a determination unit 16. The detection device 4 is a computer such as an electronic control unit, and includes a processor such as CPU or GPU, a memory such as ROM or RAM, and an I/O interface (not shown). The detection device 4 operates the processor (e.g., computation) in accordance with a program loaded to the memory, and thereby functional units of the detection device 4 are implemented.

[0023] The thermal image acquisition unit 10 receives the thermal image of the front surface Fr of the solid fuel Fg captured by the imaging device 2. The thermal image acquisition unit 10 sends the received thermal image to the luminance information output unit 12. FIG. 4 is a diagram showing an example of the thermal image of the front surface Fr of the solid fuel Fg immediately after the solid fuel is excessively supplied to the combustion chamber (immediately after the occurrence of oversupply). FIG. 5 is a diagram showing an example of the thermal image of the front surface Fr of the solid fuel Fg immediately before the solid fuel is excessively supplied to the combustion chamber (immediately before the occurrence of oversupply). In the thermal images shown in FIGs. 4 and 5, the darker the color, the lower the luminance (darker), and the lighter the color, the higher the luminance (brighter).

[0024] The luminance information output unit 12 receives the thermal image from the thermal image acquisition unit 10 and outputs luminance information of the thermal image including the luminance. The luminance information output unit 12 sends the output luminance information of the thermal image to each of the storage unit 14 and the determination unit 16.

[0025] The storage unit 14 stores the luminance information of the thermal image received from the luminance information output unit 12.

[0026] The determination unit 16 compares luminance information of the thermal image received from the luminance information output unit 12 with luminance information of the thermal image stored in the storage unit 14 to detect the amount of the solid fuel Fg supplied to the combustion chamber 108. That is, the determination unit 16 compares luminance information of the thermal image output in real time with luminance information of the thermal image output prior to the luminance information of the thermal image output in real time to detect the amount of the solid fuel Fg supplied to the combustion chamber 108. If the value of difference ΔY between the luminance in real time and the luminance output prior to the luminance in real time exceeds a preset threshold, the determination unit 16 determines that the amount of the solid fuel Fg supplied to the combustion chamber 108 is excessive (the oversupply has occurred). Although not shown, when it is determined that the oversupply has occurred, a notification device such as a display or an alarm may be used to notify the operator of the oversupply.

[0027] Further, the determination unit 16 may determine whether the oversupply has occurred, based on the difference between a first luminance that is the luminance of the thermal image at a first timing and a second luminance that is the luminance of the thermal image lower than the first luminance at a second timing later than the first timing. In the exemplary embodiment shown in FIG. 1, the first luminance is luminance included in the luminance information of the thermal image stored in the storage unit 14. The second luminance is luminance included in the luminance information of the thermal image received in real time from the luminance information output unit 12. The time difference between the first timing and the second timing may be determined in advance based on, for example, the progress of drying of the front surface Fr of the solid fuel Fg, but there is no particular limitation as long as the second timing is later than the first timing. The second timing (real time) may be, for example, timing one second after the first timing, or timing 0.1 seconds after the first timing.

[0028] (Operation and effect of supply amount detection system)

The operation and effect of the supply amount detection system 1 according to the first embodiment of the present disclosure will be described. FIG. 6 is a graph showing the

luminance of the thermal image of the front surface Fr of the solid fuel Fg before falling into the combustion chamber 108, where the vertical axis represents luminance and the horizontal axis represents time. t_1 and t_2 are the times when the oversupply has actually occurred. According to the inventors' intensive study, as shown in FIG. 6, the luminance of the thermal image of the front surface Fr of the solid fuel Fg significantly decreases at times t_1 and t_2 when the oversupply has actually occurred. Therefore, the occurrence of oversupply can be quickly detected by monitoring the luminance of the thermal image of the front surface Fr of the solid fuel Fg. As shown in FIGs. 4 and 5, the luminance of the thermal image (see FIG. 4) of the front surface Fr of the solid fuel Fg before falling into the combustion chamber 108 immediately after the occurrence of oversupply is lower than the luminance of the thermal image (see FIG. 5) of the front surface Fr of the solid fuel Fg before falling into the combustion chamber 108 immediately before the occurrence of oversupply (i.e., the solid fuel Fg protruding from the inlet 122). This is because the front surface Fr of the solid fuel Fg is dried by heat in the combustion chamber 108, whereas the inside of the solid fuel Fg is not as dry as the front surface Fr of the solid fuel Fg. In other words, when the inside of the solid fuel Fg is exposed due to the oversupply, the luminance of the thermal image of the front surface Fr of the solid fuel Fg before falling into the combustion chamber 108 is reduced.

[0029] According to the first embodiment, the supply amount detection system 1 for the incinerator 100 includes the imaging device 2 configured to capture a thermal image of the solid fuel Fg before the solid fuel Fg deposited in the feeder part 104 of the incinerator 100 falls into the combustion chamber 108, and the detection device 4 configured to detect the amount of the solid fuel Fg supplied to the combustion chamber 108, based on time transition of the luminance information of the thermal image captured by the imaging device 2. Thereby, the supply amount detection system 1 for the incinerator 100 can quickly detect the occurrence of oversupply.

[0030] Further, according to the inventors' intensive study, since the front surface Fr of the solid fuel Fg before falling into the combustion chamber 108 faces the combustion chamber 108, the front surface Fr dries faster due to heat of the combustion chamber 108 than the other

surfaces of the solid fuel Fg. That is, the occurrence of oversupply can be quickly detected by monitoring the thermal image of the front surface Fr of the solid fuel Fg before falling into the combustion chamber 108. According to the first embodiment, since the imaging device 2 captures the thermal image of the front surface Fr of the solid fuel Fg before falling into the combustion chamber 108, the occurrence of oversupply can be quickly detected.

[0031] The incinerator 100 may be provided with a sensor for measuring plant data indicating the state of the incinerator 100, and the determination unit 16 of the detection device 4 may determine whether the oversupply has occurred in consideration of the plant data. For example, the incinerator 100 may be provided with a pressure sensor for measuring the pressure in the combustion chamber 108, a temperature sensor for measuring the temperature of the exhaust gas 143 flowing through the gas duct 144, and an oxygen concentration sensor for measuring the oxygen concentration in the combustion chamber 108. Then, the determination unit 16 of the detection device 4 may determine whether the oversupply has occurred, in consideration of the pressure in the combustion chamber 108, the temperature of the exhaust gas 143, and the oxygen concentration in the combustion chamber 108. In another embodiment, the determination unit 16 may determine whether the oversupply has occurred, based on the plant data instead of time transition of the luminance information of the thermal image.

[0032] <Second Embodiment>

The supply amount detection system 1 according to the second embodiment of the present disclosure will be described. The second embodiment is different from the first embodiment in that the system further includes a dividing unit 18, a count unit 20, and a pushing direction acquisition unit 22, but the other configurations are the same as those described in the first embodiment. In the second embodiment, the same constituent elements as those in the first embodiment are associated with the same reference characters and thus not described again in detail.

[0033] FIG. 7 is a schematic functional block diagram of the detection device 4 according to the second embodiment of the present disclosure. As shown in FIG. 7, the detection device

4 further includes a dividing unit 18 and a count unit 20.

[0034] The dividing unit 18 receives the captured image of the front surface Fr of the solid fuel Fg from the thermal image acquisition unit 10 and divides the thermal image into a plurality of divided images 19. For example, as shown in FIG. 8, the dividing unit 18 divides the area P with the inlet 122 on the thermal image in a first direction W2 (vertical direction) and a second direction W3 (horizontal direction) perpendicular to the first direction to form a plurality of divided images 19 arranged in a grid along the vertical and horizontal directions.

[0035] The luminance information output unit 12 receives the thermal image from the thermal image acquisition unit 10 via the dividing unit 18 and outputs the luminance for each divided image 19. The luminance information output unit 12 sends the output luminance of each divided image 19 to each of the storage unit 14 and the determination unit 16. The storage unit 14 stores the luminance of each divided image 19 received from the luminance information output unit 12.

[0036] The count unit 20 compares the luminance of each divided image 19 at the first timing stored in the storage unit 14 with the luminance of each divided image 19 at the second timing received from the luminance information output unit 12. Then, the count unit 20 counts the number of divided images 19 in which the value of difference between the luminance (first luminance) of each of the divided images 19 at the first timing and the luminance (second luminance) of each of the divided images 19 at the second timing exceeds a preset threshold.

The determination unit 16 determines that the oversupply has occurred if the count number counted by the count unit 20 exceeds a preset number. In some embodiments, the count number may differ for each divided image 19. For example, the count number of an upper divided image 19A (19) may be larger than that of a lower divided image 19B (19) located below (on one side in the first direction W2) the upper divided image 19A. The count may increase by one when the difference between the first luminance and the second luminance in the lower divided image 19B exceeds the threshold, whereas the count may increase by two when the difference between the first luminance and the second luminance in the upper divided image 19A exceeds the threshold.

[0037] It is possible that oversupply has not occurred when the luminance is reduced in only a small area of the thermal image of the front surface Fr of the solid fuel Fg before falling into the combustion chamber 108. According to the second embodiment, the detection device 4 divides the thermal image of the front surface Fr of the solid fuel Fg into a plurality of divided images 19, and determines that the oversupply has occurred if the number (count number) of divided images 19 in which the value of difference (decrease in luminance) between the first luminance and the second luminance exceeds the threshold exceeds the set number. Thus, it is possible to precisely isolate whether the oversupply has occurred.

[0038] Additionally, as shown in FIG. 7, the detection device 4 may further include a pushing direction acquisition unit 22. The pushing direction acquisition unit 22 acquires the moving direction of the pushing arm 124 of the pushing device 110. Then, the determination unit 16 receives the moving direction of the pushing arm 124 acquired by the pushing direction acquisition unit 22 and determines whether the oversupply has occurred only while the pushing arm 124 retreats in the direction away from the combustion chamber 108. That is, the determination unit 16 performs the determination of the occurrence of oversupply while the pushing arm 124 moves in the feeder part 104 from downstream to upstream in the moving direction W1. On the other hand, the determination unit 16 does not perform the determination of the occurrence of oversupply while the pushing arm 124 moves in the feeder part 104 from upstream to downstream in the moving direction W1.

[0039] While the pushing arm 124 advances in the feeder part 104 from upstream to downstream in the moving direction W1, it pushes out the solid fuel Fg deposited in the feeder part 104, so the solid fuel Fg is supplied to the combustion chamber 108. On the other hand, while the pushing arm 124 retreats in the feeder part 104 from downstream to upstream in the moving direction W1, it does not intend to push out the solid fuel Fg deposited in the feeder part 104, so the solid fuel Fg is not supplied to the combustion chamber 108. It may be sufficient to detect the occurrence of oversupply when the solid fuel Fg is not supplied to the combustion chamber 108. According to the second embodiment, the determination unit 16 determines whether the oversupply has occurred only while the pushing arm 124 retreats in the

direction away from the combustion chamber 108. Thus, the detection device 4 can quickly detect the occurrence of oversupply when the solid fuel Fg is not supplied to the combustion chamber 108. In the second embodiment, the occurrence of oversupply is detected while the pushing arm 124 retreats, but the present disclosure is not limited to this embodiment. The occurrence of oversupply may be detected while the pushing arm 124 advances.

[0040] <Third Embodiment>

The supply amount detection system 1 according to the third embodiment of the present disclosure will be described. The third embodiment is different from the first embodiment in that the system further includes a flame position detection device 24, a supply amount determination device 26, a protruding length detection device 40, and a height detection device 42, but the other configurations are the same as those described in the first embodiment. In the third embodiment, the same constituent elements as those in the first embodiment are associated with the same reference characters and thus not described again in detail. The third embodiment may be a limited configuration of the supply amount detection system 1 described in the second embodiment.

[0041] FIG. 9 is a schematic configuration diagram of the supply amount detection system 1 according to the third embodiment of the present disclosure. As shown in FIG. 9, the supply amount detection system 1 further includes a flame position detection device 24 and a supply amount determination device 26.

[0042] The flame position detection device 24 detects the flame position X of the solid fuel Fg burned in the combustion chamber 108. FIG. 10 is a schematic configuration diagram of the flame position detection device 24 according to the third embodiment of the present disclosure. In the exemplary embodiment shown in FIG. 10, the flame position detection device 24 includes a first camera 28, and a flame position decision device 30 configured to decide the flame position X of the solid fuel Fg burned in the combustion chamber 108 based on the image captured by the first camera 28.

[0043] The first camera 28 captures an image of the flame 131 from above so that the captured image includes a boundary 133 between the combustion region 130 and the post-

combustion region 132. The above-described imaging device 2 may be provided as the first camera 28 if it can capture the image of the flame 131 from above. The flame position decision device 30 includes a first image acquisition unit 32 and a flame position decision unit 34. The first image acquisition unit 32 receives the image captured by the first camera 28 and sends the image to the flame position decision unit 34. As shown in FIG. 11, the flame position decision unit 34 replaces the image sent from the first image acquisition unit 32 with a portion (first portion 36) above a predetermined luminance and a portion (second portion 38) below the predetermined luminance. That is, the flame position decision unit 34 binarizes the image captured by the first camera 28. Then, the flame position decision unit 34 decides the downstream end of the first portion 36 in the moving direction W1 as the flame position X of the solid fuel Fg. Further, the flame position decision unit 34 calculates the distance D between the flame position X corresponding to the flame end and the boundary 133. Thus, the flame position detection device 24 detects the flame position X of the solid fuel Fg. The flame position decision unit 34 calculates the distance D when the flame position X is located downstream of the boundary 133 in the moving direction W1 (on the post-combustion region 132 side) as a positive value, and calculates the distance D when the flame position X is located upstream of the boundary 133 in the moving direction W1 (on the combustion region 130 side) as a negative value.

[0044] The supply amount determination device 26 stores (accumulates) the flame position X and the distance D of the solid fuel Fg detected by the flame position detection device 24. If the occurrence of oversupply is detected by the detection device 4, the supply amount determination device 26 determines the degree of oversupply, based on the difference ΔD in the moving direction W1 between the flame position X of the solid fuel Fg at the first timing immediately before the occurrence of oversupply and the flame position X of the solid fuel Fg at the second timing immediately after the occurrence of oversupply (difference in change of flame position X). The supply amount determination device 26 classifies the degree of oversupply into multiple levels, “high”, “intermediate”, and “low”.

[0045] When the degree of oversupply decreases, the change in the flame position X of the

solid fuel Fg decreases, while when the degree of oversupply increases, the change in the flame position X of the solid fuel Fg increases. According to the third embodiment, when the detection device 4 detects the occurrence of oversupply, the degree of oversupply is automatically determined based on ΔD . Thus, it is possible to quickly obtain the degree of oversupply.

[0046] FIG. 12 is a graph showing the difference in flame position when the detection device 4 detects the occurrence of oversupply. t_3 to t_9 are times when the detection device 4 detects the occurrence of oversupply. As described above, the detection device 4 detects the occurrence of oversupply, based on time transition of the luminance information of the thermal image, which is two-dimensional information. Therefore, as shown in FIG. 12, even if the detection device 4 detects the occurrence of oversupply at t_5 , t_6 and t_9 , the degree of oversupply may be small or the solid fuel Fg may not be excessively supplied to the combustion chamber 108 to the extent of “oversupply”, and the operation to stabilize the combustion state of the solid fuel Fg in the combustion chamber 108 may not be required. According to the third embodiment, when the detection device 4 detects the occurrence of oversupply, the supply amount determination device 26 automatically determines the degree of oversupply, which can eliminate unnecessary operation to stabilize the combustion state.

[0047] Additionally, as shown in FIG. 9, the supply amount detection system 1 may further include a protruding length detection device 40. As shown in FIG. 13, the protruding length detection device 40 detects a protruding length L of the solid fuel Fg protruding from the inlet 122 of the combustion chamber 108 toward the combustion chamber 108. In the exemplary embodiment shown in FIG. 13, the protruding length detection device 40 detects the size between the inlet 122 of the combustion chamber 108 and a most downstream portion Fr1 of the front surface Fr of the solid fuel Fg in the moving direction W1 as the protruding length L. The supply amount determination device 26 stores (accumulates) the protruding length L detected by the protruding length detection device 40. If the occurrence of oversupply is detected by the detection device 4, the degree of oversupply is determined, in consideration of the difference ΔL between the protruding length L of the solid fuel Fg at the first timing

immediately before the occurrence of oversupply and the protruding length L of the solid fuel Fg at the second timing immediately after the occurrence of oversupply.

[0048] As the protruding length L of the solid fuel Fg increases, the degree of oversupply tends to increase. Therefore, by determining the degree of oversupply in consideration of ΔL , it is possible to improve the determination accuracy of the supply amount determination device 26.

[0049] Additionally, as shown in FIG. 9, the supply amount detection system 1 may further include a height detection device 42. As shown in FIG. 13, the height detection device 42 detects a height H of the solid fuel Fg deposited on the grate 126 (floor surface) of the combustion chamber 108. In the exemplary embodiment shown in FIG. 13, the height detection device 42 detects the height H of the solid fuel Fg deposited in a predetermined position 127 close to the inlet 122 on the grate 126 included in the drying region 128. The supply amount determination device 26 stores (accumulates) the height H detected by the height detection device 42. If the occurrence of oversupply is detected by the detection device 4, the degree of oversupply is determined, in consideration of the difference ΔH between the height H of the solid fuel Fg at the first timing immediately before the occurrence of oversupply and the height H of the solid fuel Fg at the second timing immediately after the occurrence of oversupply.

[0050] As the degree of oversupply increases, the change in the height of the solid fuel Fg deposited on the grate 126 tends to increase. Therefore, by determining the degree of oversupply in consideration of ΔH , it is possible to improve the determination accuracy of the supply amount determination device 26.

[0051] <Fourth Embodiment>

An operation control system 50 for the incinerator 100 according to the fourth embodiment of the present disclosure will be described. The operation control system 50 includes the supply amount detection system 1 according to the first embodiment and an operation control device 52. In the fourth embodiment, the same constituent elements as those in the first embodiment are associated with the same reference characters and thus not described

again in detail. The operation control system 50 may include the supply amount detection system 1 according to the second embodiment or the supply amount detection system 1 according to the third embodiment instead of the supply amount detection system 1 according to the first embodiment.

5 [0052] FIG. 14 is a schematic configuration diagram of the operation control system 50 according to the fourth embodiment of the present disclosure. As shown in FIG. 14, the operation control system 50 includes the supply amount detection system 1 and the operation control device 52. The operation control system 50 and the supply amount detection system 1 may be provided as devices separate from each other, or may be provided in the same device.

10 [0053] The operation control device 52 stops the supply of the solid fuel F_g to the combustion chamber 108 when the detection device 4 detects the occurrence of oversupply. FIG. 15 is a schematic functional block diagram of the operation control device 52 according to the fourth embodiment of the present disclosure. In the exemplary embodiment shown in FIG. 15, the operation control device 52 includes a stop instruction unit 54. The stop
15 instruction unit 54 instructs the pushing device 110 to stop the operation of the pushing arm 124 when the detection device 4 detects the occurrence of oversupply. The pushing device 110 stops the operation of the pushing arm 124 upon receiving the instruction from the stop instruction unit 54.

[0054] Further, the operation control device 52 increases the amount of secondary air
20 supplied from the air supply device 112 (secondary air supply device) to the combustion chamber 108 when the detection device 4 detects the oversupply. In the embodiment shown in FIG. 15, the operation control device 52 includes a flow rate regulating unit 56. The flow rate regulating unit 56 instructs the air supply device 112 to increase the amount of secondary air supplied to the combustion chamber 108 when the detection device 4 detects the occurrence
25 of oversupply. The air supply device 112 increases the opening degree of the second flow rate regulating valve 142 upon receiving the instruction from the flow rate regulating unit 56.

[0055] If the oversupply occurs, the combustion state of the solid fuel F_g in the combustion chamber 108 becomes unstable, and unburned gas such as carbon monoxide is produced. In

order to reduce the concentration of the unburned gas, an operation may be performed to stop the supply of the solid fuel Fg to the combustion chamber 108 or to supply the secondary air to an upper portion of the combustion chamber 108. According to the fourth embodiment, it is possible to automate the operation to stop the supply of the solid fuel Fg to the combustion chamber 108 among the operations when the occurrence of oversupply is detected. Further, it is possible to automate the operation to increase the amount of secondary air supplied to the combustion chamber 108 among the operations when the occurrence of oversupply is detected.

[0056] In the case where the operation control system 50 includes the supply amount detection system 1 according to the third embodiment, the operation may be automatically performed according to the degree of oversupply. FIG. 16 is a diagram showing an example of an operation map. For example, in the exemplary embodiment shown in FIG. 16, the operation control device 52 stores an operation map M1 set in advance. The operation map M1 is a map indicating a relationship between input information including the degree of oversupply and output information including whether to stop the operation of the pushing arm 124 (whether to turn on the refuse feeding stop operation) and the opening degree of the second flow rate regulating valve 142 (secondary combustion air opening degree). Then, the stop instruction unit 54 refers to the operation map M1 to decide whether to stop the operation of the pushing arm 124. The flow rate regulating unit 56 refers to the operation map M1 to decide the opening degree of the second flow rate regulating valve 142 to instruct the air supply device 112.

[0057] Further, the operation control device 52 may be configured such that an additional operation is automatically performed according to the plant data after the operation based on the operation map M1 is performed. FIG. 17 is a diagram showing an example of an additional operation map. For example, in the exemplary embodiment shown in FIG. 17, the operation control device 52 stores an additional operation map M2 set in advance. The additional operation map M2 is a map indicating a relationship between input information including the operating state (refuse feeding state) of the pushing arm 124, the opening degree of the second flow rate regulating valve 142 (secondary combustion air opening degree), differential value

and deviation of temperature of the exhaust gas 143 flowing through the gas duct 144 (gas temperature differential value and deviation), and differential value of oxygen concentration in the combustion chamber 108, and output information including whether to start the operation of the pushing arm 124 (whether to turn off the refuse feeding stop operation) and the opening degree of the second flow rate regulating valve 142 (secondary combustion air opening degree). Then, the stop instruction unit 54 refers to the additional operation map M2 to decide whether to stop the operation of the pushing arm 124 and instructs the pushing device 110. The flow rate regulating unit 56 refers to the additional operation map M2 to decide the opening degree of the second flow rate regulating valve 142 to instruct the air supply device 112. In the fourth embodiment, the amount of secondary air supplied to the combustion chamber 108 is regulated by the second flow rate regulating valve 142, but the present disclosure is not limited to the fourth embodiment. The amount of secondary air supplied to the combustion chamber 108 may be regulated by means other than the second flow rate regulating valve 142.

[0058] (Supply amount detection method)

The supply amount detection method for the incinerator 100 is for detecting the amount of the solid fuel Fg supplied to the combustion chamber 108 of the incinerator 100. FIG. 18 is a flowchart of the supply amount detection method for the incinerator 100 according to an embodiment of the present disclosure. As shown in FIG. 18, the supply amount detection method for the incinerator 100 includes an imaging step S1 of capturing a thermal image of the solid fuel Fg before the solid fuel Fg deposited in the feeder part 104 of the incinerator 100 falls into the combustion chamber 108, and a detection step S2 of detecting the amount of the solid fuel Fg supplied to the combustion chamber 108, based on time transition of the luminance information of the thermal image captured in the imaging step S1.

Further, as shown in FIG. 18, the supply amount detection method for the incinerator 100 further includes a flame position detection step S3 of detecting the flame position X of the solid fuel Fg burned in the combustion chamber 108, and a determination step S4 of determining the degree of oversupply, based on the flame position X of the solid fuel Fg detected in the flame position detection step S3 if the occurrence of oversupply is detected in the detection step

S2. According to the exemplary embodiment shown in FIG. 18, the flame position detection step S3 is between the imaging step S1 and the detection step S2, but the present disclosure is not limited to this embodiment.

[0060] FIG. 19 is a flowchart of the flow of the determination step S4 according to an embodiment of the present disclosure. As shown in FIG. 19, when the determination step S4 starts, the process proceeds to step S41. If the amount of the solid fuel F_g supplied to the combustion chamber 108 detected in the detection step S2 is excessive (step S41: Yes), the process proceeds to step S42. If the amount of the solid fuel F_g supplied to the combustion chamber 108 detected in the detection step S2 is not excessive (step S41: No), the determination step S4 ends.

[0061] In step S42, if ΔD is equal to or more than 0.5 m (step S42: Yes), the process proceeds to step S43. If ΔD is less than 0.5 m (step S42: No), the degree of oversupply is determined to be “low”, and the determination step S4 ends.

[0062] In step S43, if ΔD is equal to or more than 0.7 m (step S43: Yes), the degree of oversupply is determined to be “high”, and the determination step S4 ends. If ΔD is less than 0.7 m (step S43: No), the degree of oversupply is determined to be “intermediate”, and the determination step S4 ends.

[0063] (Operation control method)

FIG. 20 is a flowchart of the operation control method for the incinerator 100 according to an embodiment of the present disclosure. As shown in FIG. 20, the operation control method for the incinerator 100 according to an embodiment of the present disclosure includes the above-described supply amount detection method and a stop step S5. In the stop step S5, the supply of the solid fuel F_g to the combustion chamber 108 is stopped if the oversupply is detected in the detection step S2.

[0064] Additionally, as shown in FIG. 20, the operation control method for the incinerator 100 may further include a flow rate regulating step S6 of regulating the opening degree of the second flow rate regulating valve 142 (secondary combustion air opening degree) according to the degree of oversupply determined in the determination step S4 if the supply of the solid fuel

Fg to the combustion chamber 108 is stopped in the stop step S5. If the supply of the solid fuel Fg to the combustion chamber 108 is not stopped in the stop step S5, that is, if the occurrence of oversupply is not detected, the flow rate regulating step S6 is not performed.

[0065] FIG. 21 is a flowchart of the flow of the flow rate regulating step S6 according to an embodiment of the present disclosure. As shown in FIG. 21, when the flow rate regulating step S6 starts, the process proceeds to step S61. If the degree of oversupply is determined to be “high” or “intermediate” in the determination step S4 (step S61: Yes), the secondary combustion air opening degree is regulated to 100%, and the process proceeds to step S62. If the degree of oversupply is not determined to be “high” or “intermediate”, that is, if the degree of oversupply is determined to be “low” in the determination step S4 (step S61: No), the process proceeds to step S62.

[0066] In step S62, if the supply of the solid fuel Fg to the combustion chamber 108 is being stopped and “gas temperature differential value < 0 ” continues for 10 seconds or “gas temperature deviation $< 5^{\circ}\text{C}$ ” continues for 10 seconds, that is, if the combustion state of the solid fuel Fg becomes stable (step S62: Yes), the supply of the solid fuel Fg to the combustion chamber 108 starts, and the process proceeds to step S63. Conversely, if the above conditions are not satisfied, that is, if the combustion state of the solid fuel Fg remains unstable due to the occurrence of oversupply (step S62: No), the process returns to step S62.

[0067] In step S63, if the secondary combustion air opening degree is 100% (step S63: Yes), the secondary combustion air opening degree is regulated to 40%, and the flow rate regulating step S6 ends. If the secondary combustion air opening degree is not 100% (step S63: No), the process proceeds to step S64. In step S64, if the secondary combustion air opening degree is 40%, the process proceeds to step S65. If the secondary combustion air opening degree is not 40% (step S64: No), the flow rate regulating step S6 ends.

[0068] In step S65, if “oxygen concentration differential value > 0 ” continues for 10 seconds or “oxygen concentration $> 3\%$ ” continues for 10 seconds (step S65: Yes), the secondary combustion air opening degree is regulated to 10%, and the flow rate regulating step S6 ends. Conversely, if the above conditions are not satisfied (step S65: No), the flow rate

regulating step S6 ends. The secondary combustion air opening degree described in the operation control method for the incinerator 100 is merely illustrative, and may be set freely.

[0069] The contents described in the above embodiments would be understood as follows, for instance.

5 [0070] (1) An incinerator supply amount detection system (1) according to the present disclosure for detecting the amount of solid fuel (Fg) supplied to a combustion chamber (108) of an incinerator (100) includes: an imaging device (2) configured to capture an image of the solid fuel before the solid fuel deposited in a feeder part (104) of the incinerator falls into the combustion chamber; and a detection device (4) configured to detect the amount of the solid
10 fuel supplied to the combustion chamber, based on the image captured by the imaging device.

[0071] According to the inventors' intensive study, it has been found that the oversupply of the solid fuel to the combustion chamber can be quickly detected by monitoring the image (the luminance information of the image) of the solid fuel before the solid fuel deposited in the feeder part of the incinerator falls into the combustion chamber. Specifically, the luminance
15 of the image of the solid fuel before falling into the combustion chamber immediately after the oversupply of the solid fuel to the combustion chamber is lower than the luminance of the image of the solid fuel before falling into the combustion chamber immediately before the oversupply of the solid fuel to the combustion chamber. This is because the surface of the solid fuel is dried by heat in the combustion chamber, whereas the inside of the solid fuel is not as dry as
20 the front surface of the solid fuel. In other words, when the inside of the solid fuel is exposed due to the oversupply, the luminance of the thermal image of the solid fuel before falling into the combustion chamber is reduced.

[0072] With the above configuration (1), the incinerator supply amount detection system includes the imaging device configured to capture an image of the solid fuel before the solid
25 fuel deposited in the feeder part of the incinerator falls into the combustion chamber, and the detection device configured to detect the amount of the solid fuel supplied to the combustion chamber, based on the luminance information of the image captured by the imaging device. Thereby, the incinerator supply amount detection system can quickly detect the oversupply of

the solid fuel to the combustion chamber (the occurrence of oversupply).

[0073] (2) In some embodiments, in the above configuration (1), the imaging device is configured to capture an image of a front surface (Fr) facing the combustion chamber of surfaces of the solid fuel before falling into the combustion chamber.

5 [0074] According to the inventors' intensive study, the occurrence of oversupply can be quickly detected by monitoring the image of the front surface, facing the combustion chamber, of surfaces of the solid fuel before falling into the combustion chamber. With the above configuration (2), since the imaging device captures the image of the front surface of the solid fuel before falling into the combustion chamber, it is possible to quickly detect whether the
10 amount of the solid fuel supplied to the combustion chamber is excessive.

[0075] (3) In some embodiments, in the above configuration (2), the image includes a first luminance that is luminance of the image at a first timing and a second luminance that is luminance of the image at a second timing later than the first timing, the second luminance being lower than the first luminance. The detection device is configured to detect the amount
15 of the solid fuel supplied to the combustion chamber, based on a value of difference between the first luminance and the second luminance.

[0076] With the above configuration (3), the detection device detects the amount of the solid fuel supplied to the combustion chamber, based on the value of difference between the first luminance at the first timing and the second luminance lower than the first luminance at
20 the second timing later than the first timing. Thus, it is possible to quickly detect the occurrence of oversupply.

[0077] (4) In some embodiments, in the above configuration (3), the detection device includes: a dividing unit (18) for dividing the captured image of the front surface of the solid fuel into a plurality of divided images (19); and a count unit (20) for counting the number of
25 divided images in which the value of difference between the first luminance and the second luminance exceeds a preset threshold among the plurality of divided images. The detection device is configured to detect that the amount of the solid fuel supplied to the combustion chamber is excessive if the count number counted by the count unit exceeds a preset number.

[0078] It is possible that amount of the solid fuel supplied to the combustion chamber is not excessive when the luminance is reduced in only a small area of the image of the front surface of the solid fuel before falling into the combustion chamber. With the above configuration (4), the detection device includes the dividing unit for dividing the captured image of the front surface of the solid fuel before falling into the combustion chamber into a plurality of divided images, and the count unit for counting the number of divided images in which the value of difference between the first luminance and the second luminance exceeds a preset threshold among the plurality of divided images. Further, the detection device detects the occurrence of oversupply if the count number counted by the count unit exceeds a preset number. Thus, it is possible to precisely isolate whether the oversupply has occurred.

[0079] (5) In some embodiments, in any one of the above configurations (2) to (4), the system further includes a pushing device (110) having a pushing arm (124) configured to reciprocate within the feeder part. The detection device is configured to detect the amount of the solid fuel supplied to the combustion chamber, based on a moving direction of the pushing arm.

[0080] With the above configuration (5), it is possible to quickly detect the occurrence of oversupply, in consideration of the moving direction of the pushing arm.

[0081] (6) In some embodiments, in any one of the above configurations (2) to (5), the imaging device includes an infrared camera.

[0082] With the above configuration (6), since the infrared camera is used, the image of the solid fuel before the solid fuel deposited in the feeder part of the incinerator falls into the combustion chamber can be easily captured.

[0083] (7) In some embodiments, in any one of the above configurations (2) to (5), the imaging device includes a visible light camera (6) and a filter device (8) that limits transmission wavelengths incident on the visible light camera to a predetermined wavelength range.

[0084] With the above configuration (7), since the visible light camera and the filter device are prepared, the image of the solid fuel before the solid fuel deposited in the feeder part of the incinerator falls into the combustion chamber can be easily captured.

[0085] (8) In some embodiments, in any one of the above configurations (1) to (7), the system further includes: a flame position detection device (24) configured to detect a flame position of the solid fuel combusted in the combustion chamber; and a supply amount determination device (26) configured to determine the degree of excess of the amount of the solid fuel supplied to the combustion chamber, based on a change in the flame position of the solid fuel detected by the flame position detection device if the amount of the solid fuel supplied to the combustion chamber detected by the detection device is excessive.

[0086] When the degree of the amount of oversupply of the solid fuel decreases, the change in the flame position of the solid fuel decreases, while when the degree of the amount of oversupply of the solid fuel increases, the change in the flame position of the solid fuel increases. With the above configuration (8), if the detection device detects that the amount of the solid fuel supplied to the combustion chamber is excessive, the supply amount determination device automatically determines the degree of excess of the amount of the solid fuel, based on the change in the flame position of the solid fuel. Thus, it is possible to quickly obtain the degree of excess of the amount of the solid fuel.

[0087] (9) In some embodiments, in the above configuration (8), the system further includes a protruding length detection device (40) configured to detect a protruding length of the solid fuel protruding from an inlet (122) of the combustion chamber toward the combustion chamber. The supply amount determination device is configured to determine the degree of excess of the amount of the solid fuel supplied to the combustion chamber, in consideration of a change in the protruding length of the solid fuel detected by the protruding length detection device.

[0088] As the protruding length of the solid fuel increases, the degree of excess of the amount of the solid fuel when excessively supplied to the combustion chamber increases. With the above configuration (9), the supply amount determination device determines the degree of excess of the amount of the solid fuel, in consideration of the protruding length of the solid fuel. Thus, it is possible to improve the determination accuracy of the supply amount determination device.

[0089] (10) In some embodiments, in the above configuration (8) or (9), the system further includes a height detection device (42) configured to detect a height of the solid fuel deposited on a floor surface of the combustion chamber. The supply amount determination device is configured to determine the degree of excess of the amount of the solid fuel supplied to the combustion chamber, in consideration of a change in the height of the solid fuel detected by the height detection device.

[0090] As the degree of excess of the amount of the solid fuel when excessively supplied to the combustion chamber increases, the change in the height of the solid fuel deposited on the floor surface of the combustion chamber tends to increase. With the above configuration (10), the supply amount determination device determines the degree of excess of the amount of the solid fuel, in consideration of the height of the solid fuel. Thus, it is possible to improve the determination accuracy of the supply amount determination device.

[0091] (11) An incinerator operation control system (50) according to the present disclosure includes: the incinerator supply amount detection system described in any one of the above (1) to (10); and an operation control device (52) configured to stop supply of the solid fuel to the combustion chamber if the amount of the solid fuel supplied to the combustion chamber detected by the detection device is excessive.

[0092] If the solid fuel is excessively supplied to the combustion chamber, the combustion state of the solid fuel in the combustion chamber becomes unstable, and unburned gas such as carbon monoxide is produced. In order to reduce the concentration of the unburned gas, an operation may be performed to stop the supply of the solid fuel to the combustion chamber. With the above configuration (11), it is possible to automate the operation to stop the supply of the solid fuel to the combustion chamber among the operations when the solid fuel is excessively supplied to the combustion chamber.

[0093] (12) In some embodiments, in the above configuration (11), the system further includes a secondary air supply device (112) for supplying a secondary air above the combustion chamber. The operation control system is configured to increase the amount of the secondary air supplied from the secondary air supply device to the combustion chamber if

the amount of the solid fuel supplied to the combustion chamber detected by the detection device is excessive.

[0094] If the solid fuel is excessively supplied to the combustion chamber, the combustion state of the solid fuel in the combustion chamber becomes unstable, and unburned gas such as carbon monoxide is produced. In order to reduce the concentration of the unburned gas, an operation may be performed to supply the secondary air to an upper portion of the combustion chamber. With the above configuration (12), it is possible to automate the operation to increase the amount of secondary air supplied to the combustion chamber among the operations when the occurrence of oversupply is detected.

[0095] (13) An incinerator supply amount detection method according to the present disclosure for detecting the amount of solid fuel supplied to a combustion chamber of an incinerator includes: an imaging step (S1) of capturing an image of the solid fuel before the solid fuel deposited in a feeder part of the incinerator falls into the combustion chamber; and a detection step (S2) of detecting the amount of the solid fuel supplied to the combustion chamber, based on the image captured in the imaging step.

[0096] As described above, according to the inventors' intensive study, it has been found that the oversupply of the solid fuel to the combustion chamber can be quickly detected by monitoring the image (the luminance information of the image) of the solid fuel before the solid fuel deposited in the feeder part of the incinerator falls into the combustion chamber. With the above method (13), the imaging step captures the image of the solid fuel before the solid fuel deposited in the feeder part of the incinerator falls into the combustion chamber. The detection step detects the amount of the solid fuel supplied to the combustion chamber, based on the luminance information of the image captured in the imaging step. Thus, it is possible to quickly detect the oversupply of the solid fuel to the combustion chamber.

[0097] (14) In some embodiments, in the above method (13), the method further includes: a flame position detection step (S3) of detecting a flame position of the solid fuel combusted in the combustion chamber; and a determination step (S4) of determining the degree of excess of the amount of the solid fuel supplied to the combustion chamber, based on a change in the flame

position of the solid fuel detected in the flame position detection step if the amount of the solid fuel supplied to the combustion chamber detected in the detection step is excessive.

[0098] As described above, when the degree of the amount of oversupply of the solid fuel decreases, the change in the flame position of the solid fuel decreases, while when the degree of the amount of oversupply of the solid fuel increases, the change in the flame position of the solid fuel increases. With the above method (14), if the amount of the solid fuel detected in the detection step is excessive, the determination step automatically determines the degree of excess of the amount of the solid fuel, based on the change in the flame position of the solid fuel detected in the flame position detection step. Thus, it is possible to quickly obtain the degree of excess of the amount of the solid fuel.

[0099] (15) An incinerator operation control method according to the present disclosure includes: the incinerator supply amount detection method described in the above (13) or (14); and a stop step (S5) of stopping supply of the solid fuel to the combustion chamber if the amount of the solid fuel supplied to the combustion chamber detected in the detection step is excessive.

[0100] With the above method (15), it is possible to automate the operation to stop the supply of the solid fuel to the combustion chamber among the operations when the solid fuel is excessively supplied to the combustion chamber.

Reference Signs List

[0101]

- 1 Supply amount detection system
- 2 Imaging device
- 4 Detection device
- 6 Visible light camera
- 8 Filter device
- 18 Dividing unit
- 19 Divided image
- 20 Count unit

	22	Pushing direction acquisition unit
	24	Flame position detection device
	26	Supply amount determination device
	40	Protruding length detection device
5	42	Height detection device
	50	Operation control system
	52	Operation control device
	100	Incinerator
	104	Feeder part
10	108	Combustion chamber
	110	Pushing device
	112	Air supply device (Secondary air supply device)
	122	Inlet
	124	Pushing arm
15		
	S1	Imaging step
	S2	Detection step
	S3	Flame position detection step
	S4	Determination step
20	S5	Stop step
	Fg	Solid fuel
	Fr	Front surface of solid fuel

CLAIMS

1. An incinerator supply amount detection system for detecting an amount of solid fuel supplied to a combustion chamber of an incinerator, comprising:
 - 5 an imaging device configured to capture an image of the solid fuel before the solid fuel deposited in a feeder part of the incinerator falls into the combustion chamber; and
 - a detection device configured to detect the amount of the solid fuel supplied to the combustion chamber, based on the image captured by the imaging device.
- 10 2. The incinerator supply amount detection system according to claim 1,
wherein the imaging device is configured to capture an image of a front surface facing the combustion chamber of surfaces of the solid fuel before falling into the combustion chamber.
3. The incinerator supply amount detection system according to claim 2,
 - 15 wherein the image includes a first luminance that is luminance of the image at a first timing and a second luminance that is luminance of the image at a second timing later than the first timing, the second luminance being lower than the first luminance, and
 - wherein the detection device is configured to detect the amount of the solid fuel supplied to the combustion chamber, based on a value of difference between the first luminance and the
 - 20 second luminance.
4. The incinerator supply amount detection system according to claim 3,
wherein the detection device includes:
 - a dividing unit for dividing the captured image of the front surface of the solid fuel
 - 25 into a plurality of divided images; and
 - a count unit for counting the number of divided images in which the value of difference between the first luminance and the second luminance exceeds a preset threshold among the plurality of divided images, and

wherein the detection device is configured to detect that the amount of the solid fuel supplied to the combustion chamber is excessive if the count number counted by the count unit exceeds a preset number.

- 5 5. The incinerator supply amount detection system according to any one of claims 2 to 4, further comprising a pushing device having a pushing arm configured to reciprocate within the feeder part,

wherein the detection device is configured to detect the amount of the solid fuel supplied to the combustion chamber, based on a moving direction of the pushing arm.

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6. The incinerator supply amount detection system according to any one of claims 2 to 5, wherein the imaging device includes an infrared camera.

7. The incinerator supply amount detection system according to any one of claims 2 to 5,

15 wherein the imaging device includes a visible light camera and a filter device that limits transmission wavelengths incident on the visible light camera to a predetermined wavelength range.

8. The incinerator supply amount detection system according to any one of claims 1 to 7, further comprising:

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a flame position detection device configured to detect a flame position of the solid fuel combusted in the combustion chamber; and

a supply amount determination device configured to determine the degree of excess of the amount of the solid fuel supplied to the combustion chamber, based on a change in the flame position of the solid fuel detected by the flame position detection device if the amount of the solid fuel supplied to the combustion chamber detected by the detection device is excessive.

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9. The incinerator supply amount detection system according to claim 8, further comprising

a protruding length detection device configured to detect a protruding length of the solid fuel protruding from an inlet of the combustion chamber toward the combustion chamber,

wherein the supply amount determination device is configured to determine the degree of excess of the amount of the solid fuel supplied to the combustion chamber, in consideration of a change in the protruding length of the solid fuel detected by the protruding length detection device.

10. The incinerator supply amount detection system according to claim 8 or 9, further comprising a height detection device configured to detect a height of the solid fuel deposited on a floor surface of the combustion chamber,

wherein the supply amount determination device is configured to determine the degree of excess of the amount of the solid fuel supplied to the combustion chamber, in consideration of a change in the height of the solid fuel detected by the height detection device.

11. An incinerator operation control system, comprising:

the incinerator supply amount detection system according to any one of claims 1 to 10; and

an operation control device configured to stop supply of the solid fuel to the combustion chamber if the amount of the solid fuel supplied to the combustion chamber detected by the detection device is excessive.

12. The incinerator operation control system according to claim 11, further comprising a secondary air supply device for supplying a secondary air above the combustion chamber,

wherein the operation control system is configured to increase an amount of the secondary air supplied from the secondary air supply device to the combustion chamber if the amount of the solid fuel supplied to the combustion chamber detected by the detection device is excessive.

13. An incinerator supply amount detection method for detecting an amount of solid fuel

supplied to a combustion chamber of an incinerator, comprising:

an imaging step of capturing an image of the solid fuel before the solid fuel deposited in a feeder part of the incinerator falls into the combustion chamber; and

5 a detection step of detecting the amount of the solid fuel supplied to the combustion chamber, based on the image captured in the imaging step.

14. The incinerator supply amount detection method according to claim 13, further comprising:

10 a flame position detection step of detecting a flame position of the solid fuel combusted in the combustion chamber; and

a determination step of determining the degree of excess of the amount of the solid fuel supplied to the combustion chamber, based on a change in the flame position of the solid fuel detected in the flame position detection step if the amount of the solid fuel supplied to the combustion chamber detected in the detection step is excessive.

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15. An incinerator operation control method, comprising:

the incinerator supply amount detection method according to claim 13 or 14; and

a stop step of stopping supply of the solid fuel to the combustion chamber if the amount of the solid fuel supplied to the combustion chamber detected in the detection step is excessive.

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