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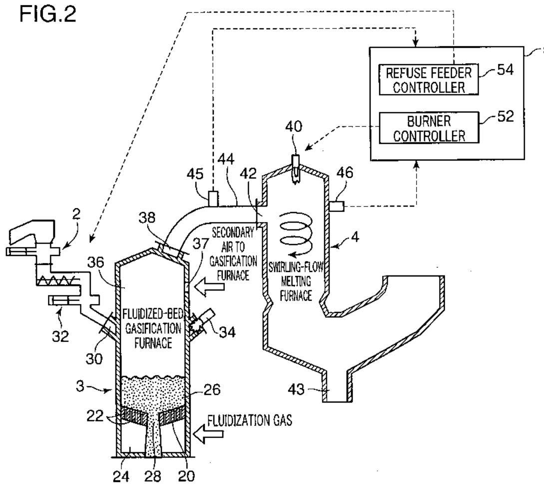
(54) OPERATING METHOD AND OPERATION CONTROL APPARATUS FOR GASIFICATION MELTING FURNACE

(57) [PROBLEMS] 1. To realize high-efficiency operation of a gasification-melting furnace by rest of an auxiliary burner while avoiding abnormal combustion of unburned gas in reignition of the auxiliary burner. 2. To facilitate a proper adjustment of the basicity without a special analyzer for a slag composition in operation of a gasification-melting furnace.

[MEANS TO SOLVE PROBLEMS] 1. The burner in the gasification-melting furnace is stopped when operation state thereof satisfies a specific condition. Thereafter, at a point in time when the temperature in the vicinity of the burner is lowered to a predetermined temperature, the supply of a waste material from a dust feeder to the gasification furnace is stopped. After this increases the concentration of oxygen in gas in outlet of the gasification furnace, the burner is reignited. 2. The basicity of slag discharged form a slag-discharge port in the melting furnace is adjusted by supply of a basicity adjuster from a basicity adjuster supplying apparatus. To determine an amount of the supply, utilized is a correlation between a parameter corresponding to the calorific value of the waste material per unit weight and the slag basicity.

FIG.2



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Description

TECHNICAL FIELD

[0001] The present invention relates to an operating method and an operation control apparatus for a gasification-melting furnace for disposal of such wastes as municipal solid wastes and industrial wastes as well as a method and an apparatus for regulating the basicity of slag discharged from the gasification-melting furnace.

BACKGROUND ART

[0002] As means for disposal of wastes, there is conventionally known a fluidized-bed gasification-melting furnace, for example, described in Patent Document 1 for example. This fluidized-bed gasification-melting furnace comprises a fluidized-bed gasification furnace having a fluidized bed formed by a fluidization gas, and a melting furnace disposed downstream therefrom. The aforementioned fluidized-bed gasification furnace produces pyrolysis gases through partial combustion of wastes thrown into the fluidized bed. The aforementioned melting furnace further combusts the pyrolysis gases produced by the fluidized-bed gasification furnace and melts ash contained in the gases, thus producing slag. Provided at the top of this melting furnace is an auxiliary burner for maintaining temperature in the furnace.

[0003] This kind of gasification-melting furnace has below-mentioned problems to be solved with respect to operation of the furnace.

1) About burner operation

[0004] In a state where the internal temperature of the aforementioned gasification-melting furnace has already reached about 1300°C, even if the auxiliary burner is turned off in that state, spontaneous combustion of unburned components will keep the in-furnace temperature high for a while. This causes a desire of a appropriate rest of the operation of the burner for fuel savings and environmental issues (especially in view of restrictions on CO_2 emissions).

[0005] However, after the burner is brought to rest as mentioned above, there can occur a case where the burner fails resume successful combustion when reignited. If the burner is reignited at a point when unburned gases existing in the proximity of the burner have reached a temperature equal to or lower than a spontaneous ignition temperature as a result of a rapid drop in in-furnace temperature near the burner for one reason or another after the stoppage of operation of the burner, for example, abnormal combustion can arise.

2) About slag fluidity

[0006] For maintaining stable discharge of slag through a slag outlet of the aforementioned gasification-melting furnace, it is important to maintain fluidity of the slag. Leaving the slag fluidity low can occur a risk that the slag might clog the slag outlet to hinder continuous furnace operation.

[0007] There exist parameters dominating the slag fluidity, including the temperature and the basicity (CaO/SiO_2) of the slag. To maintain the slag fluidity, the slag temperature must be higher than a fluxing point thereof, while the fluxing point has a significant correlation with the slag basicity. Specifically, it is known that the slag basicity exceeding a value of approximately 0.7 involves a rise of the fluxing point of the slag with an increase of the basicity. For example, the basicity of the slag of 1 is known to bring up a fluxing point of the slag to 1200°C.

[0008] Adjustment of the slag basicity is therefore important for efficient and stable continuous operation of the gasification-melting furnace. Even though the melting furnace is operated to keep an internal temperature thereof generally constant, the actual fluidity of the slag is influenced by changes in the basicity thereof. This means that stable operation is difficult without maintaining the slag basicity within a proper range. Meanwhile, if the in-furnace temperature is set at a higher level in anticipation of changes in the basicity mentioned above, low operating efficiency cannot be avoided. For example, with the slag basicity of 1, the stable discharge of the slug through the slag outlet requires a temperature thereof to be 1200°C or above. Moreover, considering that the temperature of the discharged slag tends to be lower than the temperature in the melting furnace by approximately 100-150°C, the temperature in the melting furnace should be set at 1350°C or above for stable discharge of the slag. Continuing such a high temperature operation for long periods of time not only involves requirement of increasing the amount of external fuel for in-furnace temperature maintenance and increase in running cost, but also would involve an increase in environmental load as well as in repair cost due to damages to refractory materials.

[0009] Under such circumstances, conventionally performed is to supply basicity adjusters into a system. Specifically, quartz sand (SiO_2) or the like is supplied to the system for decreasing the basicity, whereas calcium hydroxide ($Ca(OH)_2$) or the like is supplied to the system for increasing the basicity. This supply of the basicity adjusters in appropriate quantities into the system enables the slag basicity to be maintained within a preferable range. In short, determination of appropriate amounts of the basicity adjusters supply is essential to proper adjustment of the slag basicity.

[0010] As a method for determining the amounts of the aforementioned basicity adjusters supply, Patent Document 2 proposes a measurement of the actual slag basicity by use of analyzing equipment. The method disclosed in this Document includes a step of analyzing the composition of slag actually discharged from a furnace by using a simplified X-ray fluorescence spectrometer and so on, and a step of determining the amount of each basicity adjuster addition based on results of the analysis.

[0011] This method, however, involves complicated management of operation. Specifically, it requires installment of a specialized analyzer and regular analyzing operation for calculation of the slag basicity. Moreover, the analyzer is generally installed in a dedicated organization far away from a site, which requires transportation of slag samples from a waste disposal plant including the gasification-melting furnace. This causes a considerable time lag from a slag sampling to a determination of the slag basicity.

[0012] Furthermore, in this method, the reliability of analysis results is difficult to verify. In this method, generally used is an analyzing equipment installed outside the disposal facility as mentioned above, which can perform only a periodic analysis at relatively long intervals. The analysis results obtained at such infrequent intervals is extremely difficult to assess whether it is worthy of adoption or to be excluded as erratically occurred peculiar values. A failure in this assessment prevents determination of the appropriate amount of each basicity adjuster.

Patent Document 1: Japanese Unexamined Patent Publication No. 2006-29678

Patent Document 2: Japanese Unexamined Patent Publication No. 2001-182924

DISCLOSURE OF THE INVENTION

[0013] An object of a first invention of this Application is to provide a technology for carrying out highly efficient operation of a gasification-melting furnace by rest of the burner while reliably resuming successful combustion at reignition of the burner.

[0014] To achieve this object, after a stop of operation of a burner for auxiliary combustion of the melting furnace, the burner is reignited under the following condition: if the temperature in a melting furnace drops to a certain extent, the burner is reignited followed by increasing oxygen concentration in gases supplied from a gasification furnace to the melting furnace by stopping charging of waste material; or the burner is reignited during a period when the temperature in the melting furnace remains still rather high. This method prevents the burner reignition under unsuitable conditions (e.g., conditions where spontaneous ignition of unburned gas hardly occurs) in advance to thereby enable the burner to be properly reignited, while carrying out highly efficient operation by rest of the burner.

[0015] Also, a object of a second invention of this Application is to provide a technology for facilitating a proper basicity adjustment in operation of a gasification-melting furnace, with no need of special analyzer for analysis of slag composition. To achieve this object, the inventors undertook an intensive study of the basicity adjustment aforementioned, resulting in discovery of a significant correlation between the calorific value per unit weight of the waste material charged into the gasification-melting furnace and the basicity of slag discharged from the gasification-melting furnace. This correlation can be used to enable the actual basicity of the slag to be quickly and properly determined without a special analyzer or the like.

[0016] The second invention of this Application provides a method for adjusting basicity of slag in operating a gasification-melting furnace which brings waste material charged therein into pyrolysis and melts ash in pyrolysis gases produced by the pyrolysis to produce slag, the gasification-melting furnace having a slag discharging port for discharging the slag. This method comprises: a step of supplying a basicity adjuster for adjusting the basicity of the slag discharged through the slag discharging port to a position upstream therefrom; a step of detecting the weight of the waste material charged into the gasification-melting furnace per unit time; a step of detecting a parameter corresponding to the calorific value of the waste material per unit weight; a step of calculating an expected value of the basicity of the slag produced inside the gasification-melting furnace, based on a detected value of the parameter; and a step of regulating the amount of the basicity adjuster supply so as to make the basicity of the slag apploach a preset target value of the basicity, based on the calculated expected value of the basicity.

[0017] This method makes use of a correlation between the parameter corresponding to the calorific value of the waste material per unit weight and the actual basicity of the slag, the use allowing the expected value of the actual slag basicity to be obtained without a complicated analysis of the slag composition. Specifically, the expected value of the basicity can be calculated, based on the detected value of the parameter and the aforementioned correlation. Then, based on the expected value of the basicity of the slag, a proper amount of the basicity adjuster addition is determined.

[0018] This method can be realized by an apparatus for adjusting the basicity of the slag, the apparatus comprising: a basicity adjuster feeder for supplying a basicity adjuster for adjusting the basicity of the slag discharged through a slag discharging port at a position upstream from the slag discharging port; a waste material charging quantity detector for detecting the weight of waste material charged into the gasification-melting furnace per unit time; a parameter detector for detecting a parameter corresponding to the calorific value of the waste material per unit weight; an expected basicity value calculator for calculating an expected value of the basicity of the slag produced inside the gasification-melting furnace based on a detected value of the parameter, and a basicity adjuster quantity regulator for regulating the amount of the basicity adjuster supply so as to make the basicity of the slag apploach a preset target value of the basicity, based on the expected value of the basicity.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

FIG. 1 is an overall configuration diagram of a waste disposal plant provided with a gasification-melting furnace according to an embodiment of a first invention of the present Application;

FIG. 2 is a cross-sectional diagram showing the structure of the gasification-melting furnace;

FIG. 3 is a cross-sectional diagram showing an example of arrangement of a thermometer of the gasification-melting furnace;

FIG. 4 is a flowchart showing an example of a control process for determining burner reignition timing based on oxygen concentration in gas in an operation control process of the gasification-melting furnace;

FIG. 5 is a flowchart showing an example of a control process for determining the burner reignition timing based on furnace-top temperature in an operation control process of the gasification-melting furnace;

FIG. 6 is a diagram showing an example of a facility for executing a control process for determining the burner reignition timing based on a cumulative value of the amount of air in an operation control process of the gasification-melting furnace;

FIG. 7 is a flowchart showing an example of the control process for determining the burner reignition timing based on the oxygen concentration in gases in the operation control process of the gasification-melting furnace;

FIG. 8 is a diagram showing the overall configuration of a waste disposal plant according to an embodiment of a second invention of the present Application;

FIG. 9 is a graph showing an example of annual changes in the calorific value of refuse and basicity of slag;

FIG. 10 is a graph showing an example of a correlation between the calorific value of refuse and the basicity of the slag; and

FIG. 11 is a graph showing an example of setting the amount of basicity adjuster to be supplied based on an expected value of the basicity of the slag.

BEST MODES FOR CARRYING OUT THE INVENTION

[0020] There is described a preferred embodiment of a first invention of the present Application with reference to FIGS. 1 to 7.

[0021] FIG. 1 shows an example of a waste disposal plant provided with a fluidized-bed gasification-melting furnace. The present invention is widely applicable to operation of a gasification-melting furnace having a gasification furnace and a melting furnace. The overall configuration of the waste disposal plant adopting the gasification-melting furnace is not particularly limited.

[0022] Referring to FIG. 1, waste materials, that is, items of refuse are once placed in a refuse pit 1 and thrown into a hopper 2a of a refuse feeder 2 which serves as a waste feeder by an unillustrated crane. The refuse feeder 2 feeds the refuse into a fluidized-bed gasification furnace 3 in prescribed quantities.

[0023] This gasification furnace 3 performs a partial combustion process under conditions of an air ratio, for instance, of 0.2 to 0.4, that is, a pyrolysis process or primary combustion, with a fluidized bed including a layer of sand maintained at a temperature of 450°C to 650°C. Noncombustible material contained in the refuse thrown into the refuse feeder 2 is withdrawn from a furnace bottom and carried via a screw conveyer 5, a vibrating screen 6 and an unillustrated magnetic separator to be separated into noncombustible objects, nonferrous metals, ferrous metals and fluidized sand. The fluidized sand among them is returned to the layer of sand in the gasification furnace 3 for reuse.

[0024] Pyrolysis gases produced in the gasification furnace 3 are led to a melting furnace 4 to be further combusted therein under conditions of an air ratio of 1.3, for instance. Performed in this melting furnace 4 is a high-temperature combustion process at about 1300°C with a spiral flow produced therein. This high-temperature combustion generates heat, which melts ash contained in the pyrolysis gases to separate the ash as slag from the pyrolysis gases while decomposing hazardous substances like dioxins contained in the gases. The molten slag is drawn out from the bottom of the melting furnace. 4, carried out by a slag removing unit 7 including a conveyer, cooled in a slag cooling unit 8 provided therebelow, and then collected.

[0025] The exhaust gases discharged from the swirling-flow melting furnace 4 are led through an air heater 9 and a waste heat boiler 10, where heat within the pyrolysis gases is recovered. The exhaust gases after the heat-recovery are further cooled in a gas cooling unit 11 and dedusted by a bag filter 12. The exhaust gases thus cleaned are led by an induced draft fan 13 through a denitration unit 14 to be exausted through a chimney 15.

[0026] FIG. 2 shows details of the structure of the gasification-melting furnace configured with the gasification furnace 3 and the melting furnace 4.

[0027] Referring to Fig. 2, there is provided a dispersion plate 20 having a large number of gas injection orifices 22 at a bottom of the gasification furnace 3, a wind box 24 formed below the dispersion plate 20. From the wind box 24 is ejected fluidization gas for example upward through the gas injection orifices 22 in the dispersion plate 20, thus forming a fluidized bed 26 of sand particles above the dispersion plate 20. The middle of the dispersion plate 20 is provided with a noncombustible material outlet 28, through which the noncombustible material is withdrawn to be led to the screw conveyer 5 and the vibrating screen 6.

[0028] Above the fluidized bed 26 is provided a refuse input port 30 connected to the refuse feeder 2. In a path between the refuse input port 30 and the refuse feeder 2 is provided a dumper 32 for opening and closing off the path. At about the same height as the refuse input port 30 is provided a gasification furnace heat-up burner 34. Further above the gasification furnace heat-up burner 34 is formed a free board 36 for secondary combustion. At a furnace top is provided a pyrolysis gas output port 38.

[0029] The pyrolysis gases discharged through the pyrolysis gas output port 38 are fed into an upper portion of the melting furnace 4. At an appropriate location (a furnace top in the illustrated example) of the swirling-flow melting furnace 4, there is downwardly provided a burner 40 for auxiliary combustion. Immediately below this burner 40 is provided a pyrolysis gas input port 42, which is connected to the pyrolysis gas output port 38 of the gasification furnace 3 via a duct 44 serving as a pyrolysis gas channel. The burner 40 is used to raise and maintain the temperature of the melting furnace 4 (e.g. to maintain a state at a temperature of 1300°C or above). Operation of this burner 40 will be described later in detail.

[0030] Besides, the melting furnace 4 is provided with a slag discharging port 43 at the bottom thereof, to which the slag removing unit 7 is connected.

[0031] The duct 44 is provided with an oxygen analyser 45, which detects the concentration of oxygen contained in the gases fed from the gasification furnace 3 to the melting furnace 4. In the vicinity of the burner 40 (i.e., at a location close to the top of the swirling-flow melting furnace 4 in this embodiment), there is provided a thermometer 46 for detecting in-furnace temperature at the location (i.e., the temperature at the furnace top in this embodiment).

[0032] The oxygen analyser 45 preferably has superior durability. Specifically, preferable is, for example, a zirconia-type oxygen analyzer.

[0033] The thermometer 46 preferably has superb durability and excellent sensing accuracy in a high-temperature range. Specifically, a radiation pyrometer (especially an infrared radiation pyrometer) or the like is preferable. The location of this thermometer 46, though possibly determined as appropriate within a detectable range for the furnace-top temperature, is preferably determined so as to allow as stable a monitoring as possible to be made. For example, in case that a combustion air feeding nozzle 48 for the melting furnace shown in FIG. 3 is provided close to the pyrolysis gas input port 42 of the melting furnace 4, the thermometer 46 is preferably disposed at a position upstream from the nozzle 48, from which the thermometer 46 can monitor the inside of the top of the melting furnace 4 through the nozzle 48, as illustrated. This location of the thermometer 46 enables a combustion air flow from the nozzle 48 to the inside of the melting furnace 4a to be used for prevention of the ash or the like in the melting furnace 4 from clogging a detection window of the thermometer 46, thereby realizing a temperature monitoring in a stable manner.

[0034] The position of the thermometer 46 may be chosen within a range close to the burner 40, specifically so near a range to the burner 40 that the ignition of the burner 40 can cause combustion of unburned gases.

[0035] This gasification-melting furnace is further provided with a control system 50 shown in FIG. 2, into which output signals (sensing signals) from the oxygen analyser 45 and the thermometer 46 are individually input.

[0036] This control system 50 is configured with a computer and so on, functionally including a burner control section 52 and a refuse feeder control section 54. The burner control section 52 outputs command respective signals for making temporary shutdown and reignition of the burner 40. The refuse feeder control section 54 outputs respective command signals for making temporary shutdown and restart of the refuse feeder 2.

[0037] Described next is the working of this gasification-melting furnace and an operation control process performed by the control system 50 referring also to a flowchart of FIG. 4.

[0038] In a "normal operating state" (step S1) shown in FIG. 4, the refuse feeder 2 is activated and the burner 40 of the melting furnace 4 has been ignited. In this normal operating state, the refuse feeder 2 feeds refuse like municipal solid wastes into the gasification furnace 3 through the refuse input port 30 of the furnace 3. The refuse is brought into a primary combustion in the fluidized bed 26 within the furnace 3, thereby producing pyrolysis gases. The pyrolysis gases are fed from the pyrolysis gas output port 38 at the furnace top to the pyrolysis gas input port 42 of the melting furnace 4 through the duct 44 and introduced into the upper portion of the furnace 4 through the input port 42. In the melting furnace 4, combustible constituents in the pyrolysis gases further combust at a high temperature, thus producing heat which melts ash contained in the gas into slag. This slag adheres to a furnace wall, and further flows down into the slag discharging port 43 at a furnace bottom to be withdrawn to the exterior of the furnace.

[0039] The temperature at the top of the melting furnace 4 is held high by the burner 40 already ignited. However, with the furnace top temperature already reached 1300°C, spontaneous combustion of unburned components can keep the in-furnace temperature high for a while, even if operation of the auxiliary burner is stopped. Accordingly, from a viewpoint of fuel savings and environmental issues (especially in view of restrictions on CO_2 emissions), an appropriate rest of the burner operation is desirable.

[0040] For the reason, when a current operating state coincides with a preset burner stop condition (step S2), the control system 50 outputs a burner stop command signal (step S3) for stopping the operation of the burner 40.

[0041] The burner stop conditions may be set in various ways. For example, the condition may preferably include the following.

[0042] 1) There has been maintained a state in which the furnace-top temperature detected by the thermometer 46 is equal to or higher than a preset burner stop temperature (e.g., 1100°C), for a specific period of time (e.g., 30 minutes). A judgment on the "furnace-top temperature" may be made by checking an instantaneous value at appropriate sampling intervals or based on a moving average value of the furnace-top temperature for an appropriate period of time (e.g., the aforementioned specific period of time). Setting this 1) as a condition has an advantage of allowing the thermometer 46 for ascertaining fulfillment of the condition to be used also as means for taking a timing of stopping later-described refuse charge or reigniting the burner.

[0043] 2) A moving average value of low calorific values is equal to or larger than a preset calorific value (e.g., 2000 kcal/kg). The "low calorific value" referred to herein means the amount of heat possessed by the refuse fed by the refuse feeder 2 into the gasification furnace 3 per unit time, corresponding to the amount of heat of waste material.

[0044] The amount of heat possessed by the refuse, possibly calculated from heat balance of the waste disposal plant, for example as disclosed in Japanese Unexamined Patent Publication No. 2004-37049, may be approximately regarded as being equal to exhaust gas heat output Q calculated based on exhaust gas flow rate Fe (Nm^3/h) detected by an exhaust gas flow meter provided at a location downstream from the bag filter 12 and exhaust gas temperature Te (°C) detected by an exhaust gas temperature sensor provided at a like location. Specifically, given the specific heat cE of the exhaust gas, the exhaust gas heat output Q (kcal/h) is expressed in the following equation:

[0045]

$$Q = cE \times Fe \times Te$$

For more precise calorific calculation, preferably taken into consideration are a heat input by other media (e.g., air, water and auxiliary fuel of the burner 40) and a heat output by these media, in addition to the exhaust gas heat output Q, for calculation of the calorific value.

[0046] Only one or both of 1) and 2) mentioned above may be employed as the burner stop condition. Specifically, the burner 40 may be caused to stop when at least one of 1) and 2) is satisfied or when both of 1) and 2) are satisfied.

[0047] The burner stop command signal output in step S3 may be directly used as a control signal, or utilized as a notification signal for an operator. In the former case, the burner stop command signal can realize automatic control of the burner 40, when input into an actuator of the burner 40. In the latter case, the burner stop command signal can be input into for instance an operating panel to light an indicator on the operating panel, thus notifying the operator of a proper burner stop timing to enable him to stop the operation of the burner 40, by manual intervention, at a proper timing.

[0048] After thus stopping the operation of the burner 40, the burner 40 is reignitioned at a proper timing. If the burner 40 is reignited at a temperature equal to or lower than a spontaneous ignition temperature of the unburned gases after the furnace-top temperature has become equal to or lower than the spontaneous ignition temperature for one reason or another following the temporary shutdown of the burner 40, the reignition of the burner 40 may potentially induce an explosion depending on the concentration of the unburned gases.

[0049] Accordingly, the control system 50 of this embodiment outputs the refuse charging stop command signal for stopping refuse charging operation of the refuse feeder 2 (step S5) at a point in time when the furnace-top temperature detected by the thermometer 46 drops down to a preset waste charging stop temperature (900°C in this embodiment) (Yes in step S4). Similarly to the burner stop command signal, the refuse charging stop command signal also may be directly input into, for example, a driving portion of the refuse feeder 2 to function as a signal for automatically stopping the refuse charging operation of the refuse feeder 2, or may be input into the operating panel and the like for lighting the indicator thereof to function as a signal for notifying the operator of a proper refuse charging stop timing.

[0050] In step S4 above, the refuse charging stop command signal may be output immediately upon the drop down of the furnace-top temperature to the waste charging stop temperature. However, in order to exclude the risk of the reignition at a point in time when the furnace-top temperature has suddenly dropped for one reason or another, preferable is that the refuse charging stop command signal be output after a state where the furnace-top temperature is lowered to the waste charging stop temperature has been continued for a specific period of time (e.g., 2 to 20 seconds).

[0051] The aforementioned stoppage of the refuse charging operation increases the concentration of oxygen contained in the gases fed from the gasification furnace 3 to the melting furnace 4 to make a safe state for the reignition of the burner 40 in the interior of the melting furnace 4.

In view of this, the control system 50 monitors the oxygen concentration in the gases detected by the oxygen analyser 45 and outputs a burner reignition command signal (burner reignition command signal) (step S8) at a point in time when the oxygen concentration has reached a preset burner reignition concentration (burner reignition concentration; 10% in this embodiment) (Yes in step S6).

[0052] If the oxygen concentration has not increased up to the burner reignition concentration, the control system 50 outputs the burner reignition command signal at a point in time when the furnace-top temperature reaches a specific temperature (950°C in this embodiment) higher than the burner reignition temperature due to an increase in the furnace-top temperature for one reason or another (Yes in step S7). Like the burner stop signal, this signal also may be directly input into the actuator of the burner

40 to automatically reignite the burner 40, or may be input into the operating panel to indicate a proper burner reignition timing to the operator.

[0053] Thereafter, verifying that the refuse feeder 2 is ready to restart (Yes in step S9), the control system 50 outputs a restart command signal to the refuse feeder 2 to restart it (step S10). This restarting step may also be performed manually by the operator.

[0054] The above-described operation ensures a high degree of safety of restarting the burner 40 while intending fuel savings and suppression of CO_2 emissions by rest of the burner 40 at a proper timing.

[0055] Another example of operation to ensure such a high degree of safety is shown in FIG. 5. The operation control process shown in this Figure includes operation up to a point of outputting the burner reignition command signal (step S3) which is equal to what shown in FIG. 4. After the output of that signal, the control system 50 outputs the burner reignition command signal (step S12) at a point in time when the furnace-top temperature has dropped down to a preset burner reignition temperature (1000°C in this embodiment) (Yes in step S11).

[0056] The burner reignition temperature is set at so high a temperature as to reliably prevent abnormal combustion of the unburned gases due to reignition of the burner 40 at that temperature to thereby ensure a high degree of safety. In general, desirably employed is a temperature at which safety has been assured by testing or the like, the temperature being obtained by multiplying the spontaneous ignition temperature of the unburned gases (approximately 680°C in the case of natural gas, for example) by a sufficient safety factor.

[0057] This kind of operation can also prevent excessive cooling of the interior of the melting furnace 4 in advance and assure a high degree of safety of burner reignition, by reigniting the burner 40 during the in-furnace temperature drops little after temporary shutdown of the burner 40.

[0058] This operation may be performed in combination with the operation shown in FIG. 4, that is, the operation of stopping the refuse charge to increase the oxygen concentration in the gases at the output port of the gasification furnace, for providing a fail-safe feature in case the burner 40 is not shut down even when the burner reignition command signal is output in step S12 or it becomes impossible to output this signal.

[0059] The operation control process shown in FIG. 4 includes determining the burner reignition timing based on the oxygen concentration in the gas after stopping the refuse charging operation; however, as a parameter directly affecting the oxygen concentration may be monitored a cumulative value of the amount of air supplied to an side upstream from the melting furnace 4 after stoppage of the refuse charging operation, to determine the burner reignition timing based on this cumulative value. An example of this will be described with reference to FIGS. 6 and 7.

[0060] A facility shown in FIG. 6 is provided with a blower 60 and a flowmeter 62. The blower 60 is for supplying air to the gasification furnace 3, which air is supplied to the inside of the wind box 24 of the gasification furnace 3 as fluidization gas, and further delivered to the inside of the free board 36 as purging air in some cases. The pyrolysis gas output port 38 is provided at furnace top. The flowmeter 62 is provided on an outlet side of the blower 60 to detect the flow rate of air supplied from the blower 60 to the gasification furnace 3 and output a sensing signal concerning the detected flow rate. This sensing signal is input into the control system 50.

[0061] FIG. 7 shows control operation of the control system 50. FIG. 7 shows operation up to a point of outputting the refuse charging stop command signal (steps S1-S5) which is equal to the operation performed in the control process shown in FIG. 4. After the output of the refuse charging stop command signal, the burner control section 52, from a point in time when the refuse charging operation is stopped, accumulates the amount of air supplied to the gasification furnace 3 based on the aforementioned sensing signal (step S6A), and outputs the burner reignition command signal (step S8) at a point in time when the cumulative value thus obtained reaches a preset fixed value (Yes in step S6B),.

[0062] This control operation also enables the burner 40 to be reignited at a timing when the oxygen concentration in the vicinity of the burner 40 can be assumed to have increased to a certain extent as a result of air supply from the blower 60 after the temporary shutdown of the burner 40. This serves to assure a high degree of safety at the time of restarting the burner 40.

[0063] The air subject to the aforementioned accumulating step includes either air which is so supplied to the side upstream from the melting furnace 4 as to contribute to an increased oxygen concentration inside the melting furnace 4. This air is therefore not limited to the air supplied to the inside of the gasification furnace 3. For example, the purging air, if supplied to the duct 44 provided between the gasification furnace 3 and the melting furnace 4, is also included in the air subject to the accumulating step.

[0064] As thus far described, the first invention of this Application provides an operating method for operating a gasification-melting furnace provided with a gasification furnace for gasifying input waste material, a melting furnace configured to burn combustible constituents contained in pyrolysis gas produced in said gasification furnace and introduced in the melting furnace and melt ash in the pyrolysis gas, and a burner for auxiliary combustion provided in the melting furnace. This operating method comprises: stopping operation of the burner when an operating state of the gasification-melting furnace satisfies a specific burner stop condition; stopping charge of the waste material into the gasification furnace at a point in time when the temperature within the melting furnace in the vicinity of the burner drops down to a preset waste charging stop temperature after the operation of the burner has stopped; reigniting the burner at a point in time when oxygen concentration in the gas delivered from the gasification furnace to the melting furnace increases up to a preset burner reignition concentration after the charge of the waste material is stopped.

[0065] The position where the "temperature within the melting furnace in the vicinity of the burner" is detected, may be appropriately determined within a range where the burner reignition can cause a combustion of unburned gas.

[0066] The expression "stopping charge of the waste material into the gasification furnace at a point in time when the temperature within the melting furnace in the vicinity of the burner drops down to a preset waste charging stop temperature" includes not only stopping the charge of the waste material at the moment when the temperature within the gasification furnace has dropped the waste charging stop temperature, but also stopping the charge of the waste material after a state in which the furnace-top temperature remains lowered to the waste charging stop temperature has been continued for a preset period of time, to exclude a case of sudden drop of the furnace-top temperature.

[0067] According to this operating method, at a point in time when the temperature within the melting furnace in the vicinity of the burner drops down to the preset waste charging stop temperature (e.g., on the occurrence of a temperature state in which spontaneous combustion of the unburned gas has become difficult) after the burner is stopped operating, at first, stopping the charge of the waste material into the gasification furnace can increase the oxygen concentration in the gas delivered from the gasification furnace to the melting furnace, and thereafter, the burner reignition at a point in time when the oxygen concentration has increased up to the preset burner reignition concentration can ensure prevention of abnormal combustion of the unburned gas due to the reignition, thus ensuring successful combustion.

[0068] Meanwhile, at a point in time when the temperature within the melting furnace in the vicinity of the burner increases up to a preset temperature higher than the waste charging stop temperature (e.g., a temperature sufficiently high to prevent the abnormal combustion of the unburned gas) after the burner has stopped operating, the burner may be reignited regardless of the oxygen concentration.

[0069] In this operating method, after the operation of the burner is stopped when the operating state of the gasification furnace satisfies a specified burner stop condition, the burner may be reignited at a point in time when the temperature within the melting furnace in the vicinity of the burner has dropped down to the preset waste charging stop temperature. This approach also can prevent reignition of the burner in an excessively low temperature range thereof (e.g., an temperature range in which spontaneous combustion of the unburned gas hardly occurs), thus assuring successful combustion.

[0070] The burner stop condition may be set as appropriate. However, if this burner stop condition is such a condition that the temperature within the melting furnace in the vicinity of the burner or a moving average value thereof has been kept equal to or higher than a preset burner stop temperature for a specific period of time, means for detecting the aforementioned temperature can be used to take the waste charging stop timing or the burner reignition timing as well to make a judgment on the burner stop condition.

[0071] In this operating method, after stopping the operation of the burner when the operating state of the gasification-melting furnace satisfies the specific burner stop condition and stopping charge of the waste material into the gasification furnace at a point in time when the temperature within the melting furnace in the vicinity of the burner drops down to the preset waste charging stop temperature after the burner has stopped operating, the operation for reigniting the burner may be performed when the cumulative value of the amount of air supplied to the side upstream from the melting furnace from a point in time when the charging of the waste material is stopped reaches a fixed value. This performance allows a reignition while ensuring a sufficient oxygen concentration in a combustion range of the burner, thus assuring successful combustion.

[0072] Provided as an operation control apparatus for performing the above-described operating method is an apparatus comprising: a waste feeder for charging the waste material into the gasification furnace; a thermometer for detecting the temperature within the melting furnace in the vicinity of the burner; an oxygen analyser for detecting oxygen concentration in the gas fed from the gasification furnace to the melting furnace; and a control system for controlling operation of the gasification furnace based on detection results of the thermometer and the oxygen analyser. The aforementioned control system includes a burner controller which outputs a burner stop command signal for stopping the operation of the burner when an operating state of the gasification-melting furnace satisfies a specific burner stop condition, and a waste charging controller which outputs a waste charging stop command signal for stopping the waste charge from charging the waste material into the gasification furnace at a point in time when the temperature detected by the thermometer drops down to a preset waste charging stop temperature after the burner has stopped operating. The burner controller outputs a burner reignition command signal for reigniting the burner at a point in time when the oxygen concentration detected by the oxygen analyser increases up to a preset burner reignition concentration after the waste feeder has stopped charging the waste material.

[0073] In this apparatus, after the burner has stopped operating, the burner controller may output the burner reignition signal regardless of the oxygen concentration at a point in time when the temperature within the melting furnace in the vicinity of the burner detected by the thermometer increases up to a preset temperature higher than the waste charging stop temperature.

[0074] Also provided as another operation control apparatus for performing the above-described operating method is an apparatus comprising: a waste feeder for charging waste material into a gasification furnace; a thermometer for detecting the temperature within a melting furnace in the vicinity of a burner; and a control system for controlling operation of the burner based on detection results of the thermometer; wherein the control system outputs a burner stop signal for stopping the operation of the burner when an operating state of the gasification-melting furnace satisfies a specific burner stop condition as well as a burner reignition signal for restarting the operation of the burner at a point in time when the temperature detected by the thermometer drops down to a preset burner reignition concentration after the burner has stopped operating.

[0075] It is preferable that the burner stop condition of the above-described apparatus includes that the temperature detected by the thermometer or a moving average value thereof has been kept equal to or higher than a preset burner stop temperature for a specific period of time.

[0076] Also provided as another operation control apparatus for performing the above-described operating method is an apparatus comprising: a burner controller which outputs a burner stop signal for stopping operation of a burner when an operating state of a gasification-melting furnace satisfies a specific burner stop condition; and a waste charging controller which outputs a waste charging stop command signal for stopping a waste feeder from charging the waste material into a gasification furnace at a point in time when the temperature detected by a thermometer drops down to a preset waste charging stop temperature after the burner has stopped operating, wherein the burner controller accumulates the amount of air detected by the air quantity detector from a point in time when the waste feeder has stopped charging the waste material and outputs a burner reignition signal for restarting the operation of the burner at a point in time when a cumulative value thus obtained reaches a preset fixed value.

[0077] Each of the above-described operation control apparatuses can configure an excellent gasification-melting furnace in combination with a gasification furnace for gasifying input waste material, a waste feeder for charging the waste material into the gasification furnace, a melting furnace configured to burn combustible constituents contained in pyrolysis gas produced in said gasification furnace and introduced in the melting furnace and melt ash in the pyrolysis gas, and a burner for combustion provided in the melting furnace.

[0078] Next described is an embodiment of a second invention of the present Application with reference to FIG. 8.

[0079] FIG. 8 shows the overall configuration of a waste disposal plant including a gasification-melting furnace to which the present second invention is applied. This plant is provided with a gasification-melting furnace 110, a refuse feeding section 112 for feeding waste materials, that is, items of refuse to the gasification-melting furnace 110 and a gas treatment section 114 for treating gases discharged from the gasification-melting furnace 110.

[0080] The refuse feeding section 112 is equipped with a refuse pit 116, a refuse mover 118 and a refuse feeder 120. The refuse pit 116 receives and once stores the items of refuse to be treated that are carried in from outside the plant. The refuse mover 118, provided with a crane, grasps the refuse in the refuse pit 116 and moves the same to the refuse feeder 120. The refuse feeder 120 has a hopper 122, which receives the refuse fed from the refuse mover 118. The amount of charged refuse corresponds to a refuse charging quantity fed into the gasification-melting furnace 110. The refuse feeder 120, incorporating a screw conveyer, supplies the refuse thrown into the hopper 122 to the gasification-melting furnace 110.

[0081] The gasification-melting furnace 110 has a gasification furnace 124 and a melting furnace 126. The gasification furnace 124 performs pyrolytisis of the refuse charged from the refuse feeder 120, thereby producing pyrolysis gases. As the gasification furnace 124, can be employed, for example, a known fluidized-bed furnace or kiln. The melting furnace 126 combusts combustible constituents in the pyrolysis gases at a high temperature to melt ash contained in the gases into slag. The slag adheres to a furnace wall of the melting furnace 126, for instance. The melting furnace 126 is provided with a slag discharging port 128 at a furnace bottom. The slag discharging port 128 is for discharging the slag that adheres to the furnace wall and flows down therefrom to the exterior of the furnace. In this melting furnace 126, combustion of auxiliary fuel by an unillustrated burner for adjusting in-furnace temperature is performed as required.

[0082] The gas treatment section 114 is provided with a waste heat boiler 130, a cooling chamber 132, a dust collector 134, an induced draft fan 136 and a chimney 138.

[0083] The waste heat boiler 130 is for recovering heat from high-temperature exhaust gas discharged from the melting furnace 126, specifically for producing steam by using the heat possessed by the exhaust gas and discharging the steam. The flow rate of the discharged steam, i.e., the amount of steam produced in the waste heat boiler 130 per unit time, serves as a parameter corresponding to the calorific value of the refuse charged into the gasification-melting furnace 110 per unit time.

[0084] The cooling chamber 132 is equipped with a tower structure into which gas discharged from the waste heat boiler 130 is introduced, a sprayer for spraying cooling water into the tower structure, a temperature sensor for detecting gas temperature at an outlet of the tower structure and a controller for regulating the flow rate of the cooling water supplied by the sprayer so as to make the outlet gas temperature detected by the temperature sensor keep constant.

[0085] The dust collector 134 captures dust or the like contained in the gas discharged from the cooling chamber 132. The dust-removed gas from the dust collector 134 is discharged through the chimney 138 via the induced draft fan 136.

[0086] This plant further includes a basicity adjusting unit 140. The basicity adjusting unit 140, for adjusting the basicity of the slag discharged through the slag discharging port 128 of the melting furnace 126, comprises a basicity adjuster feeder 142, a steam flowmeter 144, a refuse charging quantity output portion 146 and a controller 150.

[0087] The basicity adjuster feeder 142, for supplying a basicity adjuster into the refuse charged into the gasification furnace 124, comprises a screw conveyer 147 which serves as transport means for supplying the basicity adjuster and a motor 148 for turning the screw conveyer 147. The basicity adjuster is appropriately selected. This embodiment is intended only to excessively high basicity of the discharged slag, so that quartz sand (SiO_2) for decreasing the basicity of the slag is selected as the basicity adjuster.

[0088] The steam flowmeter 144 measures the flow rate of the discharged steam, that is, the amount of steam produced in the waste heat boiler 130 per unit time.

[0089] The refuse charging quantity output portion 146 outputs an information signal concerning the weight of the refuse charged into the gasification furnace 124 per unit time. Specifically, the refuse charging quantity output portion 146 is additionally provided to the refuse mover 118 to calculate the amount of refuse convey based on the weight load applied to the refuse mover 118 and the number of moving operations, and to provide it to the controller 150 as information regarding the amount of refuse charge into the gasification-melting furnace 110.

[0090] The controller 150, configured with a microcomputer and so on, has a function of totally controlling the entirety of the plant, including an expected basicity value calculator 152 and a basicity adjuster quantity regulator 154 to serve a function of adjusting the basicity of the slag.

[0091] The expected basicity value calculator 152 calculates a predicted value of the basicity of the slag discharged from the slag discharging port 128, based on the information signal concerning the weight of the refuse charged into the gasification furnace 124 per unit time and the flow rate of the steam measured by the steam flowmeter 144. Calculation of this expected value is accomplished by a step of calculating the calorific value of refuse per unit weight based on the amount of refuse charged per unit time and the flow rate of the discharged steam and a step of calculating the predicted value of the basicity based on the calorific value of refuse per unit weight.

[0092] There is a correlation between the flow rate of the discharged steam or the calorific value of the refuse per unit weight and the slag basicity. This correlation can be predetermined by actual measurements. Specifically, measuring the actual slag basicity corresponding to the flow rate of the steam by an analyzer for a particular period of time enables the correlation to be estimated, as shown in later-discussed Examples. The correlation can be approximately expressed for example in a first-degree equation (a linear equation).

[0093] The expected basicity value calculator 152 stores the correlation and calculates the expected value of the basicity based on the correlation and the flow rate of the steam actually measured by the steam flowmeter 144.

[0094] As a value of the flow rate of the discharged steam on which the calculation of the expected value of the basicity is based, adopted is an average value of values by the steam flowmeter 144 during a specific period of time. This period of time can be set as appropriate, preferably at about 6 to 24 hours in general terms.

[0095] The basicity adjuster quantity regulator 154 determines the amount of the basicity adjuster supply for making the basicity approach a preset target value (e.g., 0.5) , based on the expected value of the slag basicity calculated by the expected basicity value calculator 152 and the information signal concerning the weight of the charged refuse input from the refuse charging quantity output portion 146. Then, to obtain the determined amount of supply, the basicity adjuster quantity regulator 154 outputs a control signal to the motor 148 of the basicity adjuster feeder 142 to control the rotation speed thereof. In advance can be prepared a relationship between the expected value and the actual amount of the basicity adjuster supply, based on theory or simulation.

[0096] In the above-described apparatus and method of adjusting the slag basicity performed in this apparatus, with a focus on the parameter (flow rate of the steam discharged from the waste heat boiler 130 herein) concerning the calorific value of the refuse which is closely related to the basicity, the expected value of the basicity is calculated based on detected values of that parameter and the relationship. This allows the amount of the basicity adjuster to be supplied to be properly and quickly determined with a simple configuration using an existing plant, unlike a conventional method in which operation is carried paralleling measurement of the actual slag basicity by an analyzer.

[0097] This method can be carried out even within a plant not including the aforementioned waste heat boiler 130. In this case, as a parameter concerning the calorific value of the refuse can be selected, for example, a flow rate of the cooling water supply in the cooling chamber 132. Since this cooling chamber 132, as previously described, is provided with the temperature sensor for detecting gas temperature at the outlet of the tower structure and the controller for regulating the flow rate of the cooling water supply by the sprayer so as to keep constant the outlet gas temperature detected by the temperature sensor, the flow rate of the cooling water supply corresponds to the calorific value of the refuse charged into the gasification-melting furnace 110 per unit time.

[0098] A feeding position of the basicity adjuster is not limited to an inlet side of the gasification furnace 124, permitted to be appropriately determined in a range upstream from the slag discharging port 128. For example, the position may be determined within a range between the gasification furnace 124 and the melting furnace 126 or inside a combustion chamber of the melting furnace 126 upstream from the slag discharging port 128 thereof.

EXAMPLES

[0099] Here are described examples concerning adjustment of the basicity of the slag in the waste disposal plant shown in FIG. 8.

[0100] 1) About correlation between calorific value of refuse per unit weight and basicity of slag

There exists a correlation between the calorific value of the refuse per unit weight and the basicity of the slag, which correlation can be approximately assumed to be a first-degree function.

[0101] FIG. 9 shows annual changes in the calorific value of refuse per unit weight (kcal/kg) and basicity of slag in a certain waste disposal plant. This Figure clearly indicates that the calorific value of the refuse and the basicity vary similarly to each other.

[0102] FIG. 10 is a graphical representation of respective relationships between the calorific value of refuse and basicity of slag determined by actual measurements in two waste disposal plants (plant A and plant B). As shown in this Figure, either of plants A and B has a specific relationship between the calorific value of refuse and basicity of slag. The two plants A and B are so different from each other in components of the refuse charged into the gasification-melting furnaces thereof that the respective relationships between the calorific value of refuse and the basicity of slag in the plants A and B differ from each other, while both of the relationships can be approximately assumed to be first-degree functions. Accordingly, each relationship, when input and stored into the expected basicity value calculator 52 in advance, enables the calculator 52 to quickly calculate an expected value of the slag basicity based on the parameter corresponding to the calorific value of the refuse (e.g., flow rate of the steam discharged from the waste heat boiler 30).

[0103] 2) About relationship between expected value of basicity of slag and amount of basicity adjuster

It is possible to determine the relationship between the expected value of the slag basicity and the amount of the basicity adjuster supply in advance based on theory or simulation. For example, under the assumption of only down adjustment of the slag basicity, a relationship between the amount of the basicity adjuster (e.g., quartz sand) to be supplied (the amount of supply corresponding to the amount of refuse charged per unit time) and the expected value of the basicity is preferably set as shown in FIG. 11. According to this setting, when the expected value of the basicity exceeds a target value (e.g., 0.5), the basicity adjuster is supplied in a quantity corresponding to an excess amount of the expected value.

[0104] As thus far described, the second invention of this Application provides a method of adjusting basicity of slag in operating a gasification-melting furnace which brings charged waste material into pyrolysis and melts ash in pyrolysis gas produced by the pyrolysis, the gasification-melting furnace having a slag discharging port for discharging the slag produced by melting the ash. The basicity adjusting method comprising: a step of supplying a basicity adjuster for adjusting the basicity of the slag discharged through the slag discharging port at a position upstream therefrom; a step of detecting the weight of the waste material charged into the gasification-melting furnace per unit time; a step of detecting a parameter corresponding to the calorific value of the waste material per unit weight; a step of calculating an expected value of the basicity of the slag produced inside the gasification-melting furnace based on a detected value of the parameter, and a step of regulating the amount of the basicity adjuster supply toward a preset target value of the basicity, based on the calculated expected value of the basicity.

[0105] In this basicity adjusting method, utilizing a correlation between the parameter corresponding to the calorific value of the waste material per unit weight and the actual slag basicity allows the expected value of the actual slag basicity to be obtained without a complicated analysis of the slag composition. In short, the expected value of the basicity can be calculated based on the detected value of the parameter and the correlation. Based on the expected value of the slag basicity, a proper amount of the basicity adjuster addition is determined.

[0106] Specifically, as the parameter corresponding to the calorific value of the waste material per unit weight is effectively detected an amount of steam produced in a waste heat boiler per unit time by use of heat of gas discharged from the gasification-melting furnace. The amount of steam production is easily detected. Moreover, based on the amount of steam thus produced and the amount of the waste material charged into the gasification-melting furnace per unit time, the calorific value of the waste material per unit weight can be properly calculated.

[0107] As specific means for calculating the expected value of the basicity, for example, effective is a method including a step of determining a relationship between the parameter and the actual slag basicity by actual measurement, in advance of the step of calculating the expected value of the basicity of the slag produced in the gasification-melting furnace, wherein the expected value of the basicity of the slag produced in the gasification-melting furnace is calculated based on the relationship and the detected value of the parameter. In this method, a proper expected value of the basicity of the slag is quickly calculated based on the relationship between the predetermined parameter and the actual slag basicity.

[0108] Also provided is a basicity adjusting apparatus of a gasification-melting furnace for performing the above-described basicity adjusting method. This apparatus comprises: a basicity adjuster feeder for supplying a basicity adjuster for adjusting basicity of slag discharged through a slag discharging port at a position upstream therefrom; a waste material charging quantity detector for detecting the weight of waste material charged into the gasification-melting furnace per unit time; a parameter detector for detecting a parameter corresponding to the calorific value of the waste material per unit weight; an expected basicity value calculator for calculating an expected value of the basicity of the slag produced inside the gasification-melting furnace based on a detected value of the parameter; and a basicity adjuster quantity regulator for regulating the amount of the basicity adjuster supply so as to make the slag basicity approach a preset target value of the basicity, based on the expected value of the basicity.

[0109] The parameter detector of this apparatus, for example, preferably detects the amount of steam produced in a waste heat boiler per unit time by use of heat of gas discharged from the gasification-melting furnace. In this case, the expected basicity value calculator can calculate the calorific value of the waste material per unit weight based on the parameter detected by the parameter detector and the amount of the waste material charged into the gasification-melting furnace per unit time.

[0110] Also, the basicity adjuster quantity regulator, for example, preferably stores a relationship between the parameter determined by actual measurement and the actual basicity of the slag, and determines the amount of the basicity adjuster supply based on the relationship thus stored and the detected value of the parameter.

Claims

1. An operating method of a gasification-melting furnace for operating said gasification-melting furnace provided with a gasification furnace for gasifying input waste material, a melting furnace configured to burn combustible constituents contained in pyrolysis gas produced in said gasification furnace and introduced in the melting furnace and melt ash in the pyrolysis gas, and a burner for auxiliary combustion provided in said melting furnace, said operating method comprising:

operation of stopping operation of said burner when an operating state of said gasification-melting furnace satisfies a specific burner stop condition;
operation of stopping charge of the waste material into said gasification furnace at a point in time when the temperature within said melting furnace in the vicinity of said burner drops down to a preset waste charging stop temperature after said burner has stopped operating; and
reigniting said burner at a point in time when oxygen concentration in the gas delivered from said gasification furnace to said melting furnace increases up to a preset burner reignition concentration after the charge of the waste material is stopped.

2. The operating method of the gasification-melting furnace as recited in claim 1, wherein said burner is reignited regardless of the oxygen concentration at a point in time when the temperature within said melting furnace in the vicinity of said burner increases up to a preset temperature higher than the waste charging stop temperature, after.said burner has stopped operating.

3. An operating method of a gasification-melting furnace for operating said gasification-melting furnace provided with a gasification furnace for gasifying input waste material, a melting furnace configured to burn combustible constituents contained in pyrolysis gas produced in said gasification furnace and introduced in the melting furnace and melt ash in the pyrolysis gas, and a burner for auxiliary combustion provided in said melting furnace, said operating method comprising:

operation of stopping operation of said burner to stop operating when an operating state of said gasification-melting furnace satisfies a specific burner stop condition; and
operation of reigniting said burner at a point in time when the temperature within said melting furnace in the vicinity of said burner has dropped down to a preset waste charging stop temperature.

4. An operating method of a gasification-melting furnace for operating said gasification-melting furnace provided with a gasification furnace for gasifying input waste material, a melting furnace configured to burn combustible constituents contained in pyrolysis gas produced in said gasification furnace and introduced in the melting furnace and melt ash in the pyrolysis gas, and a burner for auxiliary combustion provided in said melting furnace, said operating method comprising:

operation of stopping operation of said burner when an operating state of said gasification-melting furnace satisfies a specific burner stop condition;
operation of stopping charge of the waste material into said gasification furnace at a point in time when the temperature within said melting furnace in the vicinity of said burner drops down to a preset waste charging stop temperature after said burner has stopped operating; and

operation of reigniting said burner at a point in time when a cumulative value of the amount of air supplied to an side upstream from said melting furnace from a point in time when the charge of the waste material is stopped reaches a fixed value.

5. The operating method of the gasification-melting furnace as recited in one of claims 1 to 4, wherein the burner stop condition includes that a state in which the temperature within said melting furnace in the vicinity of said burner or a moving average value thereof is equal to or higher than a preset burner stop temperature is maintained for a specific period of time.

6. An operation control apparatus of a gasification-melting furnace for controlling operation of said gasification-melting furnace provided with a gasification furnace for gasifying input waste material, a melting furnace configured to burn combustible constituents contained in pyrolysis gas produced in said gasification furnace and introduced in the melting furnace and melt ash in the pyrolysis gas, and a burner for auxiliary combustion provided in said melting furnace, said operation control apparatus comprising:

a waste feeder for charging the waste material into said gasification furnace;
a thermometer for detecting the temperature within said melting furnace in the vicinity of said burner;
an oxygen analyser for detecting oxygen concentration in the gas fed from said gasification furnace to said melting furnace; and
a control system for controlling operation of said gasification furnace based on detection results of said thermometer and said oxygen analyser, said control system including:

a burner controller which outputs a burner stop command signal for stopping operation of said burner when an operating state of said gasification-melting furnace satisfies a specific burner stop condition, and
a waste charging controller which outputs a waste charging stop command signal for stopping said waste charge from charging the waste material into said gasification furnace at a point in time when the temperature detected by said thermometer drops down to a preset waste charging stop temperature after said burner has stopped operating;

wherein the burner controller outputs a burner reignition command signal for reigniting said burner at a point in time when the oxygen concentration detected by said oxygen analyser increases up to a preset burner reignition concentration after said waste feeder has stopped charging the waste material.

7. The operation control apparatus of the gasification-melting furnace as recited in claim 6, wherein the burner controller outputs the burner reignition signal regardless of the oxygen concentration at a point in time when the temperature detected by said thermometer increases up to a preset temperature higher than the waste charging stop temperature after said burner has stopped operating.

8. The operation control apparatus of the gasification-melting furnace as recited in claim 6 or 7, wherein the burner stop condition includes that the temperature detected by said thermometer or a moving average value thereof has been kept equal to or higher than a preset burner stop temperature for a specific period of time.

9. An operation control apparatus of a gasification-melting furnace for controlling operation of said gasification-melting furnace provided with a gasification furnace for gasifying input waste material, a melting furnace configured to burn combustible constituents contained in pyrolysis gas produced in said gasification furnace and introduced in the melting furnace and melt ash in the pyrolysis gas, and a burner for auxiliary combustion provided in said melting furnace, said operation control apparatus comprising:

a waste feeder for charging the waste material into said gasification furnace;
a thermometer for detecting the temperature within said melting furnace in the vicinity of said burner; and
a control system for controlling operation of said burner based on detection results of said thermometer;

wherein said control system outputs a burner stop signal for stopping operation of the burner when an operating state of said gasification-melting furnace satisfies a specific burner stop condition as well as a burner reignition signal for restarting the operation of said burner at a point in time when the temperature detected by said thermometer drops down to a preset burner reignition concentration after said burner has stopped operating.

10. The operation control apparatus of the gasification-melting furnace as recited in claim 9, wherein the burner stop condition includes that the temperature detected by said thermometer or a moving average value thereof has been kept equal to or higher than a preset burner stop temperature for a specific period of time.

11. An operation control apparatus of a gasification-melting furnace for controlling operation of said gasification-melting furnace provided with a gasification furnace for gasifying input waste material, a melting furnace configured to burn combustible constituents contained in pyrolysis gas produced in said gasification furnace and introduced in the melting furnace and melt ash in the pyrolysis gas, an air feeder for supplying air to an side upstream from said melting furnace, and a burner for auxiliary combustion provided in said melting.furnace, said operation control apparatus comprising:

a waste feeder for charging the waste material into said gasification furnace;
an air quantity detector for detecting the amount of air supplied by said air feeder; and
a control system for controlling operation of said burner, said control system including:

a burner controller which outputs a burner stop command signal for causing said burner to stop operating when an operating state of said gasification-melting furnace satisfies a specific burner stop condition, and
a waste charging controller which outputs a waste charging stop command signal for stopping said waste feeder from charging the waste material into said gasification furnace at a point in time when the temperature detected by said thermometer drops down to a preset waste charging stop temperature after said burner has stopped operating;

wherein said burner controller accumulates the amount of air detected by said air quantity detector from a point in time when said waste feeder has stopped charging the waste material and outputs a burner reignition signal for restarting the operation of said burner at a point in time when a cumulative value thus obtained reaches a preset fixed value after said waste feeder has stopped charging the waste material.

12. A gasification-melting furnace comprising:

a gasification furnace for gasifying input waste material;
a waste feeder for charging the waste material into said gasification furnace;
a melting furnace configured to burn combustible constituents contained in the pyrolysis gas introduced into the melting furnace and melt ash in the gas;
a burner for combustion provided in said melting furnace; and
said operation control apparatus of the gasification-melting furnace as recited in one of claims 5 to 11.

13. A method of adjusting basicity of slag in operating a gasification-melting furnace which brings charged waste material into pyrolysis and melts ash in pyrolysis gas produced by the pyrolysis to produce slag, said gasification-melting furnace having a slag discharging port for discharging the slag to the exterior of said furnace, said basicity adjusting method comprising:

a step of supplying a basicity adjuster for adjusting the basicity of the slag discharged through said slag discharging port at a position upstream therefrom;
a step of detecting the weight of the waste material charged into said gasification-melting furnace per unit time;
a step of detecting a parameter corresponding to the calorific value of the waste material per unit weight;
a step of calculating an expected value of the basicity of the slag produced inside said gasification-melting furnace based on a detected value of the parameter; and
a step of regulating the amount of the basicity adjuster supply so as to make the basicity of the slag approach a preset target value of the basicity based on the calculated expected value of the basicity.

14. The method of adjusting the basicity of the slag in said gasification-melting furnace as recited in claim 13, wherein the amount of steam produced in a waste heat boiler per unit time is detected by use of heat of gas discharged from said gasification-melting furnace as said parameter, and the calorific value of the waste material per unit weight is calculated based on the amount of steam thus produced and the amount of the waste material charged into said gasification-melting furnace per unit time.

15. The method of adjusting the basicity of the slag in said gasification-melting furnace as recited in claim 13 or 14, said basicity adjusting method further comprising:

a step of determining a relationship between said parameter and the actual basicity of the slag by actual measurement in advance of said step of calculating the expected value of the basicity of the slag produced in said gasification-melting furnace;

wherein the expected value of the basicity of the slag produced in said gasification-melting furnace is calculated based on said relationship and the detected value of the parameter in said step of calculating the expected value.

16. A basicity adjusting apparatus for adjusting basicity of slag in operating a gasification-melting furnace which brings charged waste material into pyrolysis and melts ash in pyrolysis gas produced by the pyrolysis to produce slag, said gasification-melting furnace having a slag discharging port for discharging the slag to the exterior of said furnace, said basicity adjusting apparatus comprising:

a basicity adjuster feeder for supplying a basicity adjuster for adjusting the basicity of the slag discharged through said slag discharging port at a position upstream therefrom;
a waste material charging quantity detector for detecting the weight of the waste material charged into said gasification-melting furnace per unit time;
a parameter detector for detecting a parameter corresponding to the calorific value of the waste material per unit weight;
an expected basicity value calculator for calculating an expected value of the basicity of the slag produced inside said gasification-melting furnace based on a detected value of the parameter, and
a basicity adjuster quantity regulator for regulating the amount of the basicity adjuster supply so as to make the basicity of the slag approach a preset target value of the basicity based on the expected value of the basicity.

17. The basicity adjusting apparatus for adjusting the basicity of the slag in said gasification-melting furnace as recited in claim 16, wherein said parameter detector detects the amount of steam produced in a waste heat boiler which produces the steam by using heat of gas discharged from said gasification-melting furnace, and said expected basicity value calculator calculates the calorific value of the waste material per unit weight based on the amount of steam detected by said parameter detector and the amount of the waste material charged into said gasification-melting furnace per unit time.

18. The basicity adjusting apparatus for adjusting the basicity of the slag in said gasification-melting furnace as recited in claim 16 or 17, wherein said basicity adjuster quantity regulator stores a relationship between the parameter determined by actual measurement and the actual basicity of the slag and determines the amount of the basicity adjuster to be supplied based on the relationship thus stored and the detected value of the parameter.

FIG.1

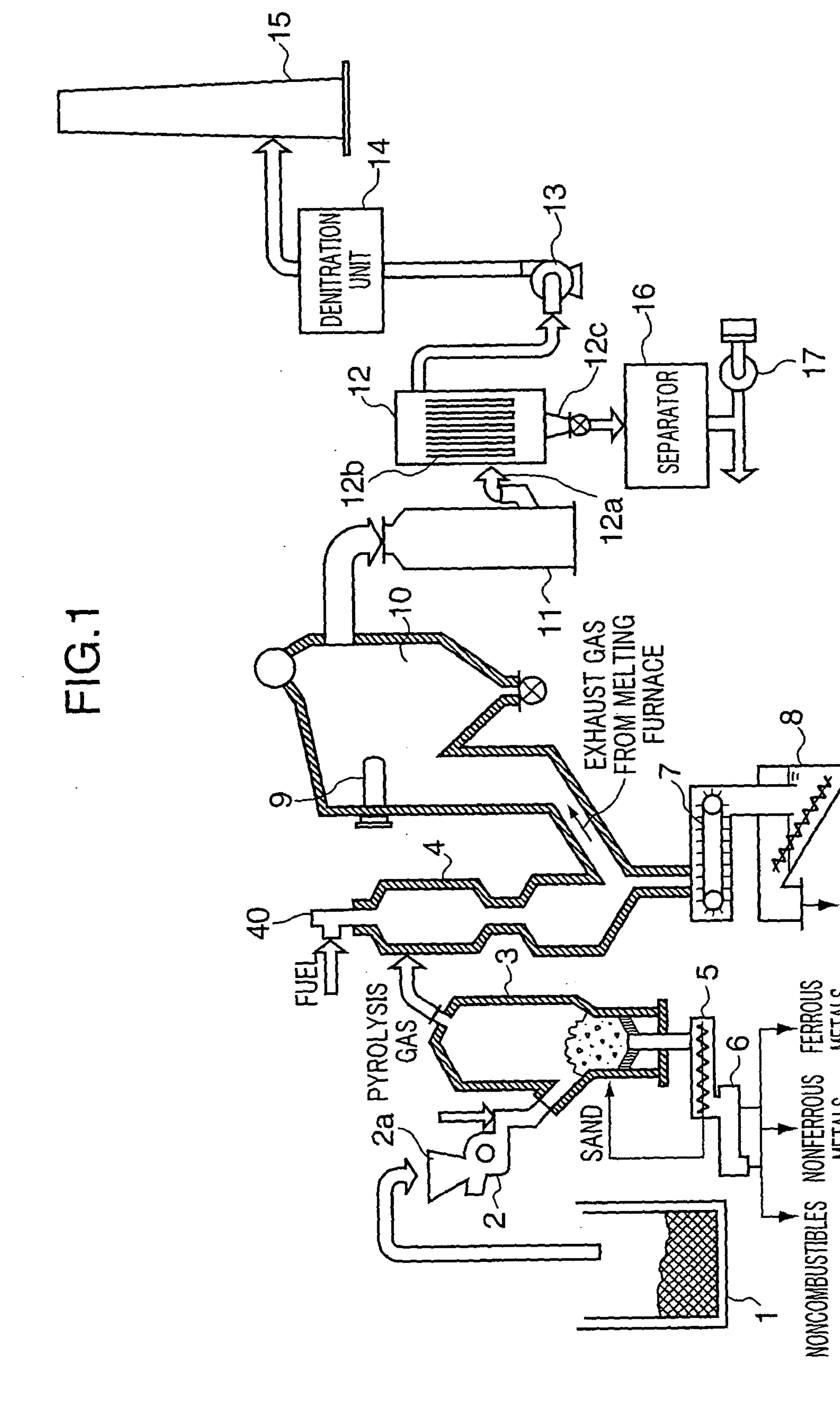

15
14
DENITRATION UNIT
13
12
12c
16
SEPARATOR
17
12b
12a
10
11
9
EXHAUST GAS FROM MELTING FURNACE
8
7
4
40
FUEL
MOLTEN SLAG
3
5
PYROLYSIS GAS
2a
2
6
SAND
FERROUS METALS
NONFERROUS METALS
NONCOMBUSTIBLES
1

FIG.2

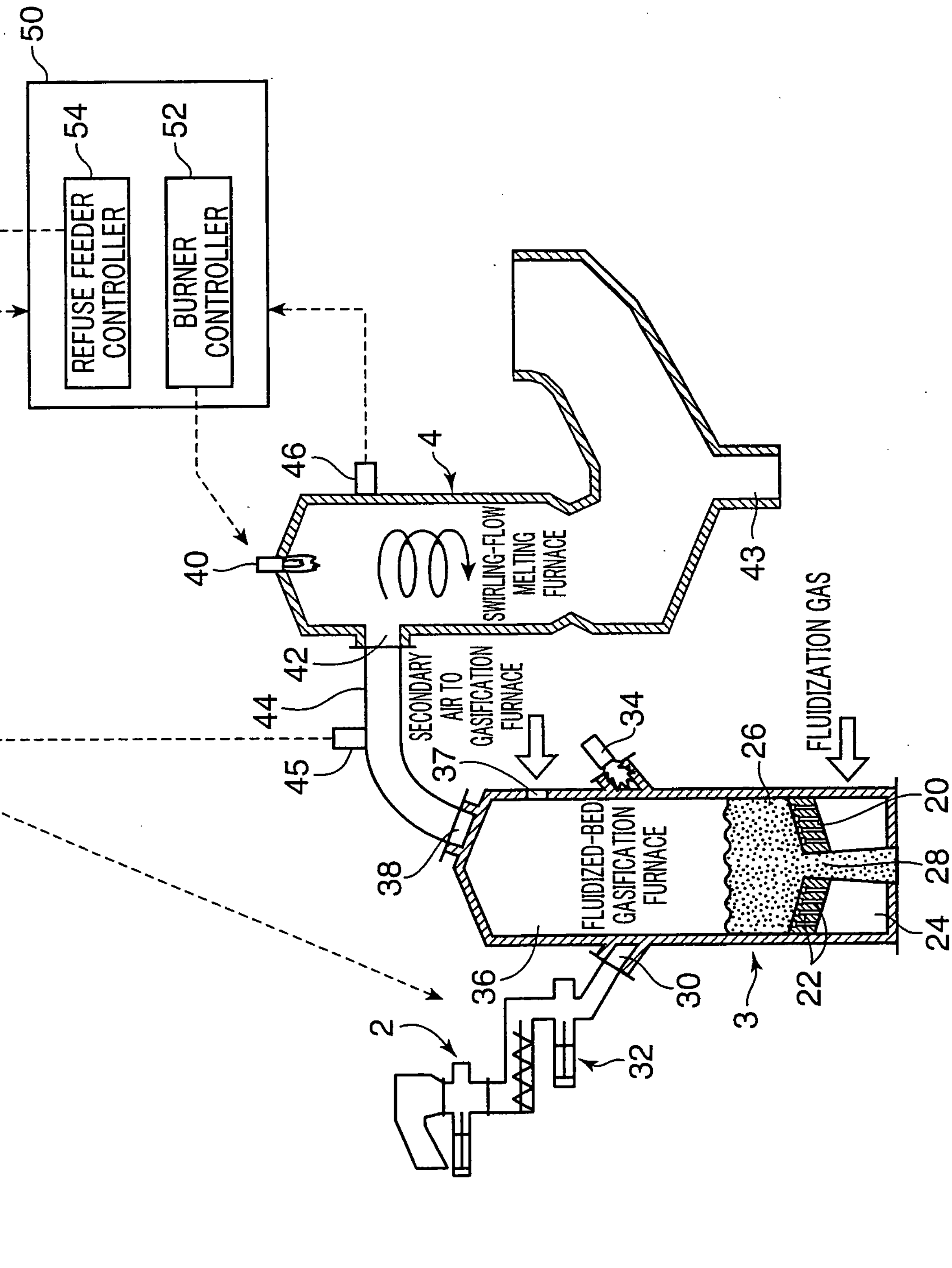

50
54
REFUSE FEEDER CONTROLLER
52
BURNER CONTROLLER
46
4
40
SWIRLING-FLOW MELTING FURNACE
43
42
44
45
SECONDARY AIR TO GASIFICATION FURNACE
37
34
38
FLUIDIZED-BED GASIFICATION FURNACE
26
FLUIDIZATION GAS
20
28
24
22
36
30
3
2
32

FIG.3

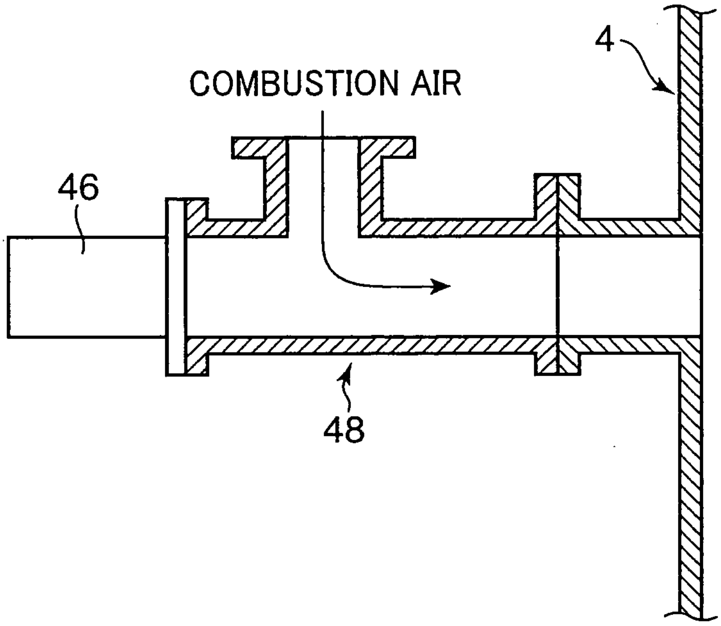


FIG.4

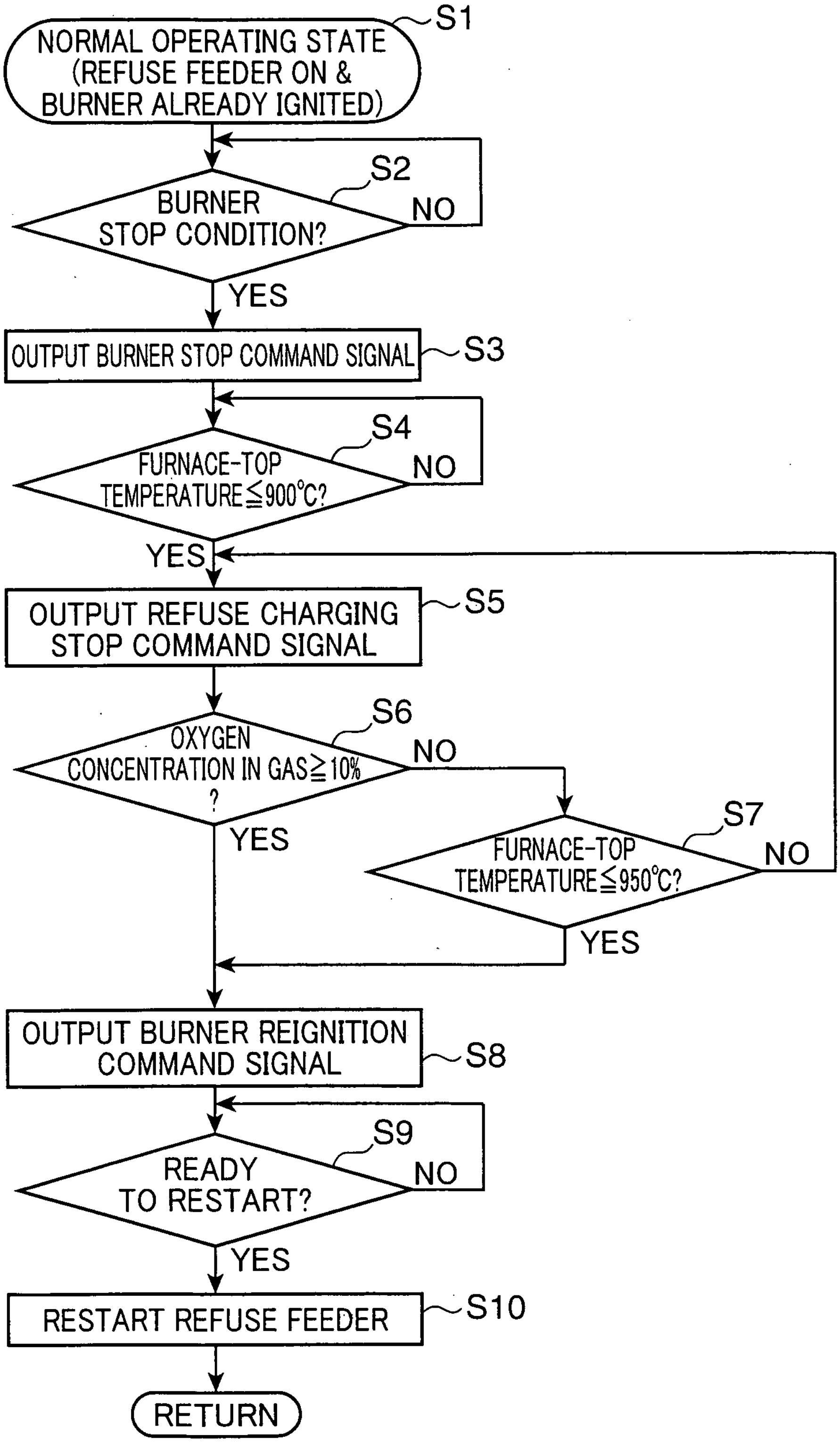

NORMAL OPERATING STATE (REFUSE FEEDER ON & BURNER ALREADY IGNITED)
S1
BURNER STOP CONDITION?
S2
NO
YES
OUTPUT BURNER STOP COMMAND SIGNAL
S3
FURNACE-TOP TEMPERATURE≦900°C?
S4
NO
YES
OUTPUT REFUSE CHARGING STOP COMMAND SIGNAL
S5
OXYGEN CONCENTRATION IN GAS≧10% ?
S6
NO
YES
FURNACE-TOP TEMPERATURE≦950°C?
S7
NO
YES
OUTPUT BURNER REIGNITION COMMAND SIGNAL
S8
READY TO RESTART?
S9
NO
YES
RESTART REFUSE FEEDER
S10
RETURN

FIG.5

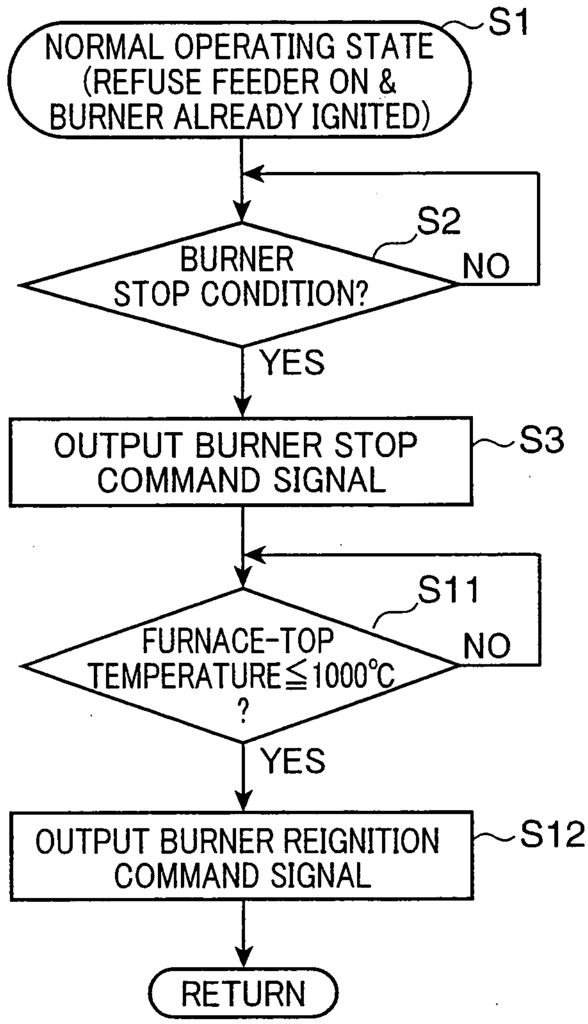

S1
NORMAL OPERATING STATE (REFUSE FEEDER ON & BURNER ALREADY IGNITED)
S2
BURNER STOP CONDITION?
NO
YES
OUTPUT BURNER STOP COMMAND SIGNAL
S3
S11
FURNACE-TOP TEMPERATURE≦1000℃ ?
NO
YES
OUTPUT BURNER REIGNITION COMMAND SIGNAL
S12
RETURN

FIG.6

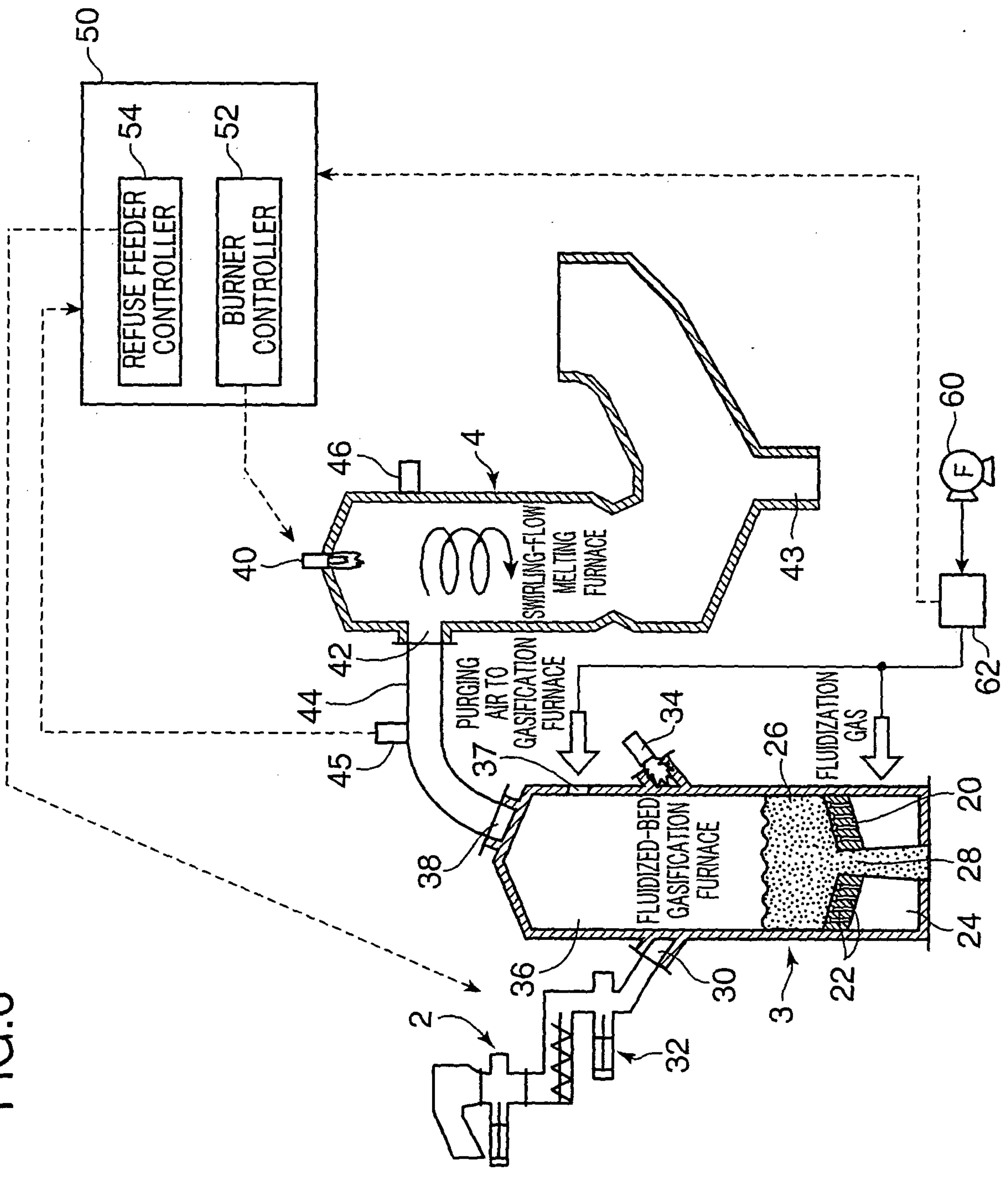

50
54
REFUSE FEEDER CONTROLLER
52
BURNER CONTROLLER
46
4
40
SWIRLING-FLOW MELTING FURNACE
43
60
F
62
42
44
45
PURGING AIR TO GASIFICATION FURNACE
34
37
26
FLUIDIZATION GAS
20
28
24
22
38
FLUIDIZED-BED GASIFICATION FURNACE
36
30
3
2
32

FIG.7

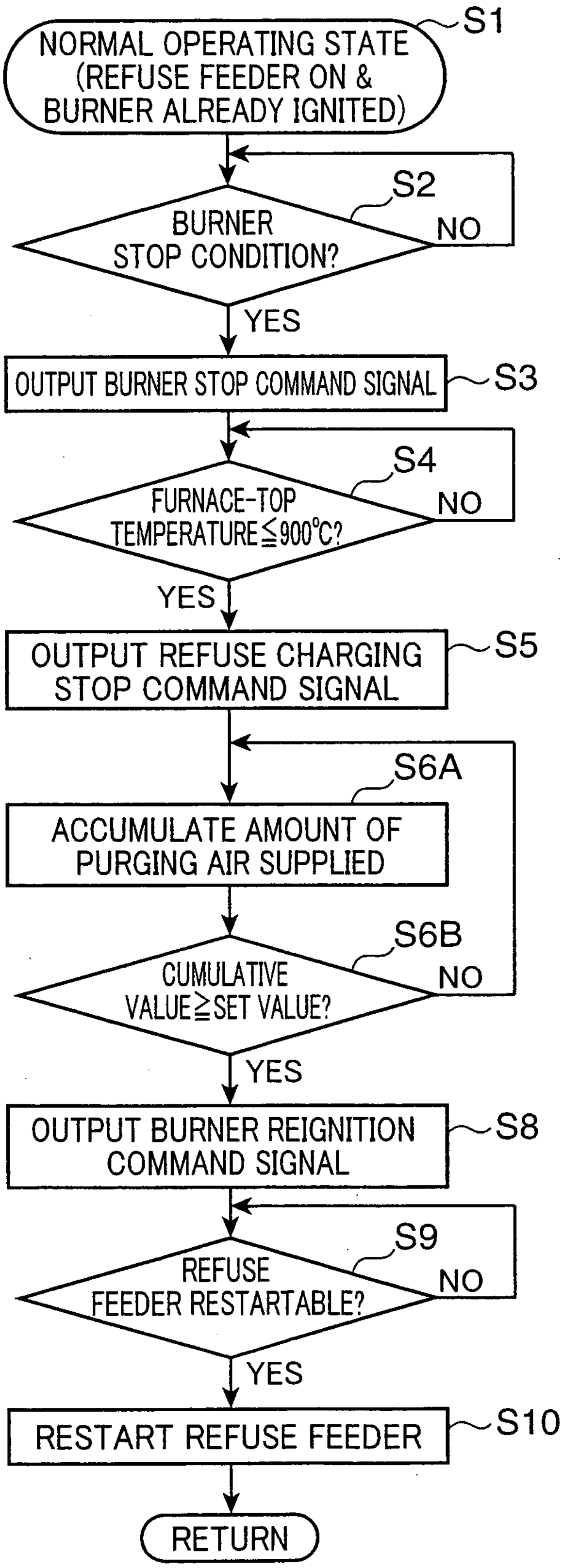
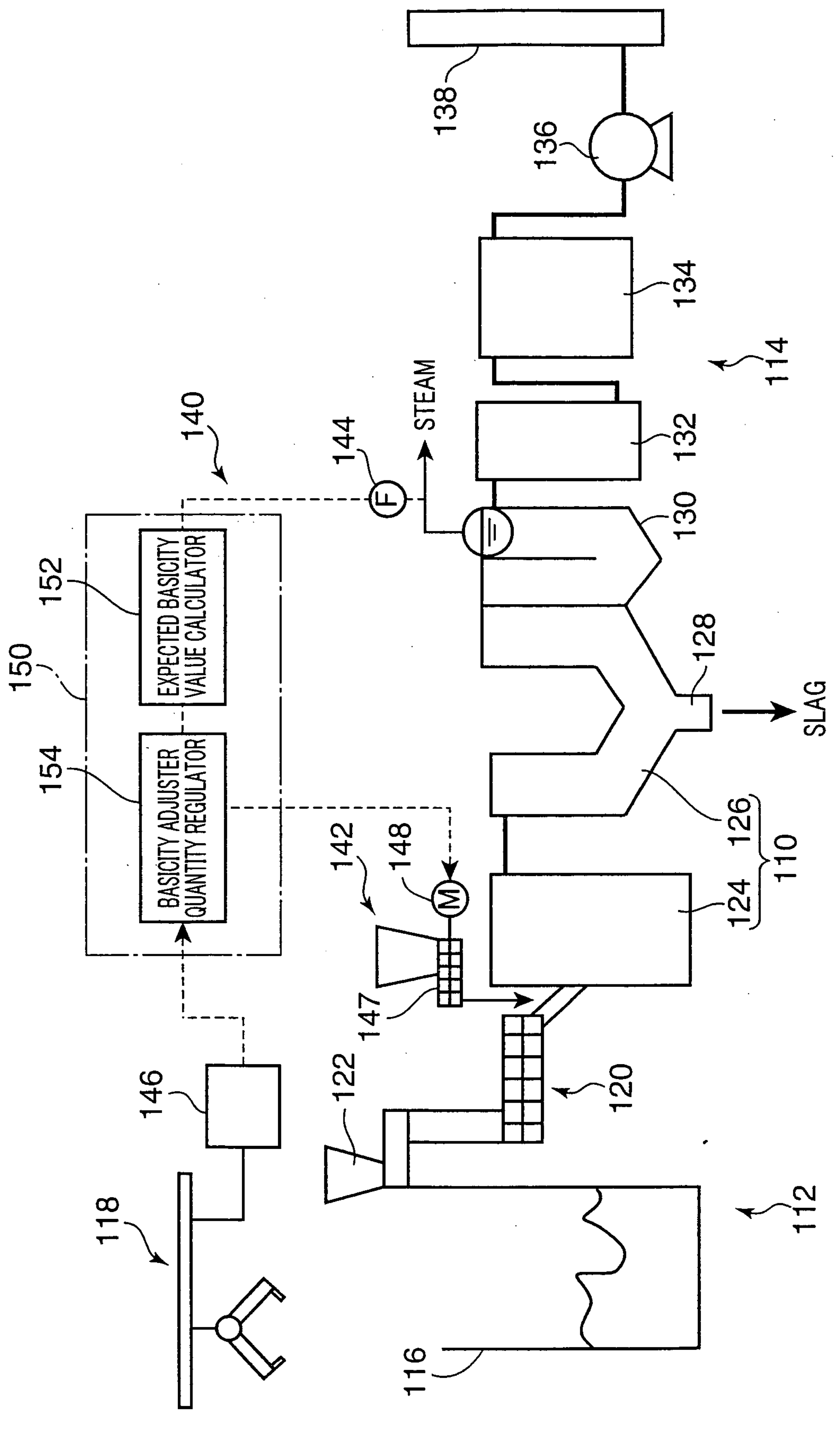

S1
NORMAL OPERATING STATE (REFUSE FEEDER ON & BURNER ALREADY IGNITED)
S2
BURNER STOP CONDITION?
NO
YES
OUTPUT BURNER STOP COMMAND SIGNAL
S3
S4
FURNACE-TOP TEMPERATURE≦900°C?
NO
YES
OUTPUT REFUSE CHARGING STOP COMMAND SIGNAL
S5
S6A
ACCUMULATE AMOUNT OF PURGING AIR SUPPLIED
S6B
CUMULATIVE VALUE≧SET VALUE?
NO
YES
OUTPUT BURNER REIGNITION COMMAND SIGNAL
S8
S9
REFUSE FEEDER RESTARTABLE?
NO
YES
RESTART REFUSE FEEDER
S10
RETURN

FIG.8



138
136
134
114
132
STEAM
144
F
140
130
152
EXPECTED BASICITY VALUE CALCULATOR
150
128
SLAG
154
BASICITY ADJUSTER QUANTITY REGULATOR
126
110
124
142
148
M
147
122
120
146
118
112
116

FIG.9

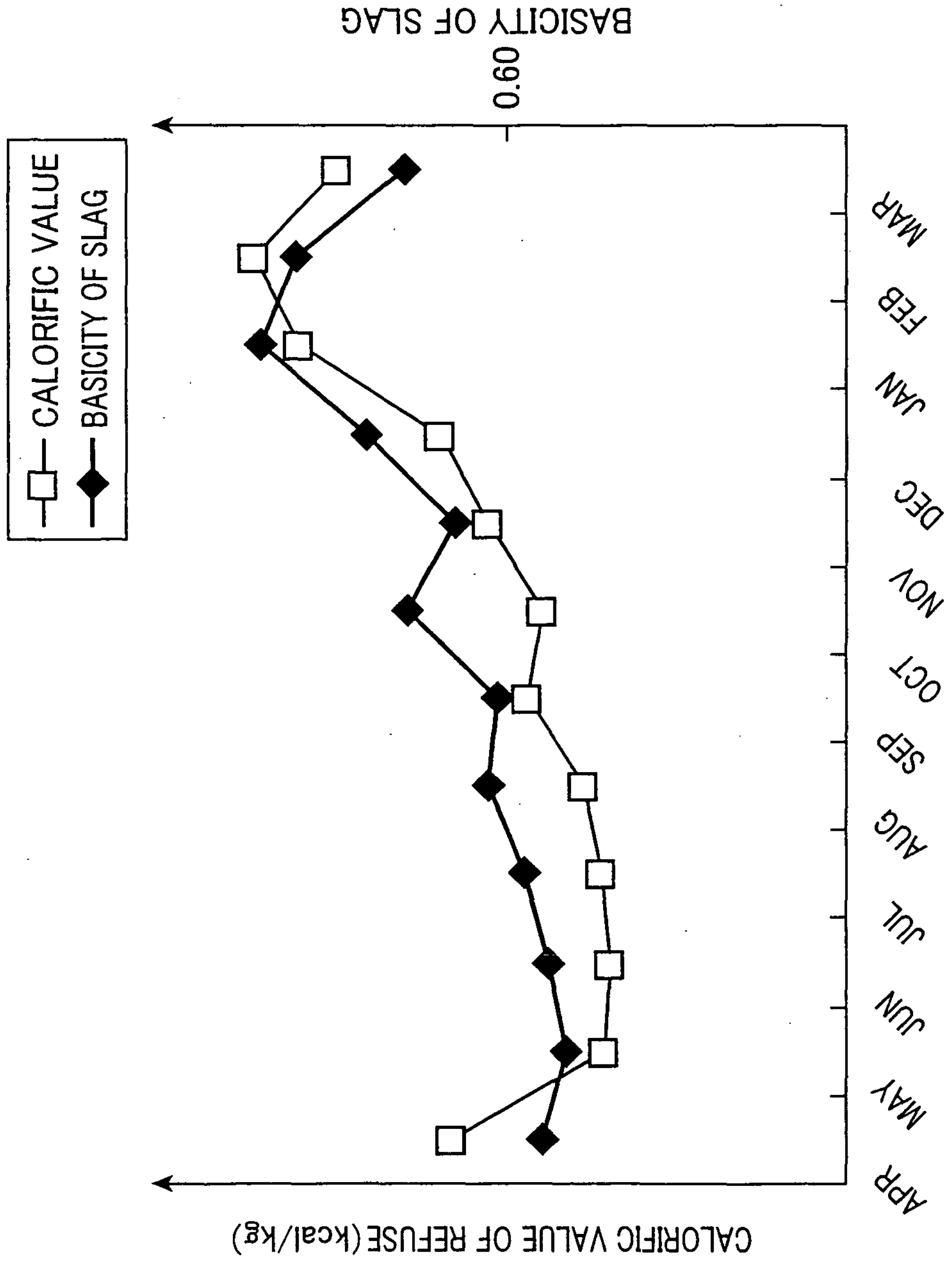

CALORIFIC VALUE
BASICITY OF SLAG
BASICITY OF SLAG
0.60
CALORIFIC VALUE OF REFUSE (kcal/kg)
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR

FIG.10

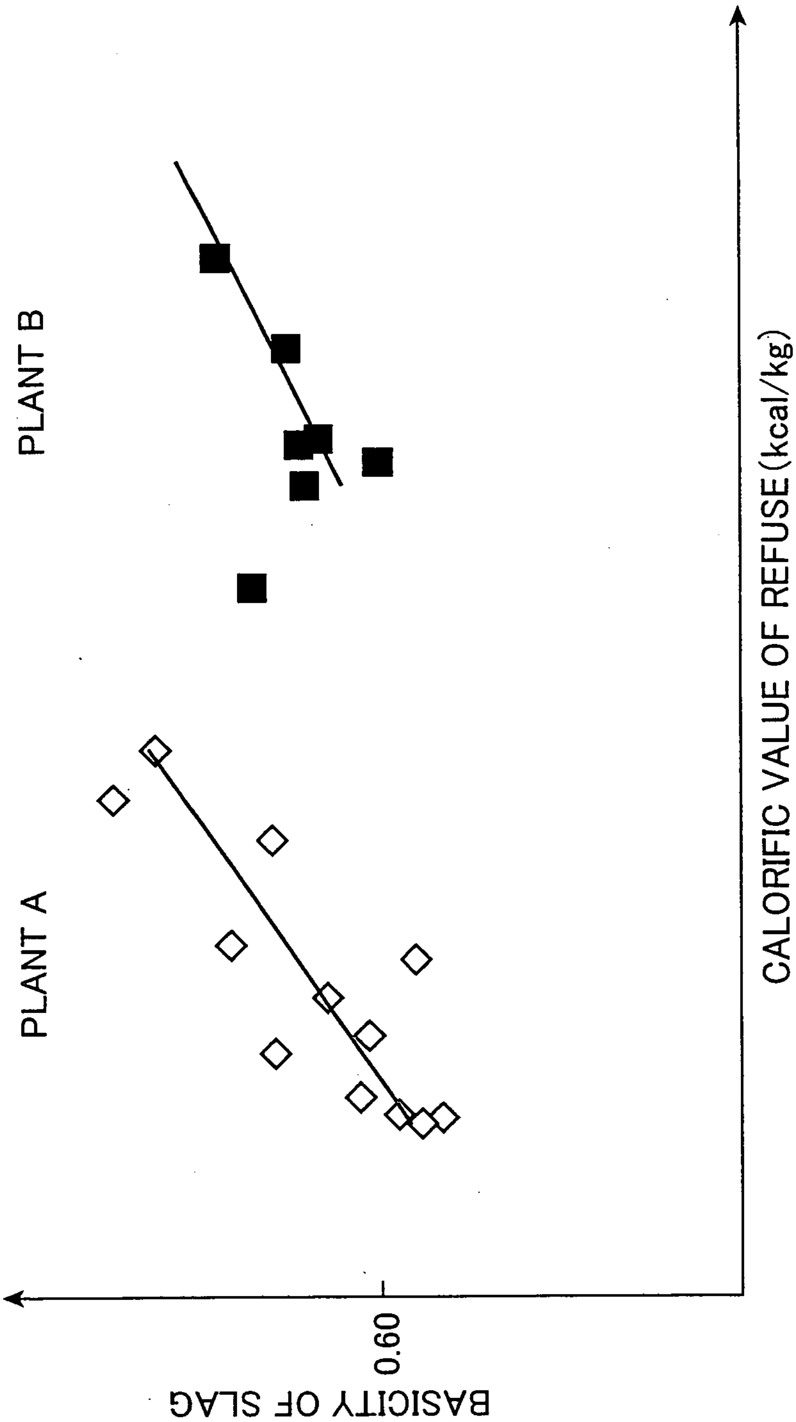
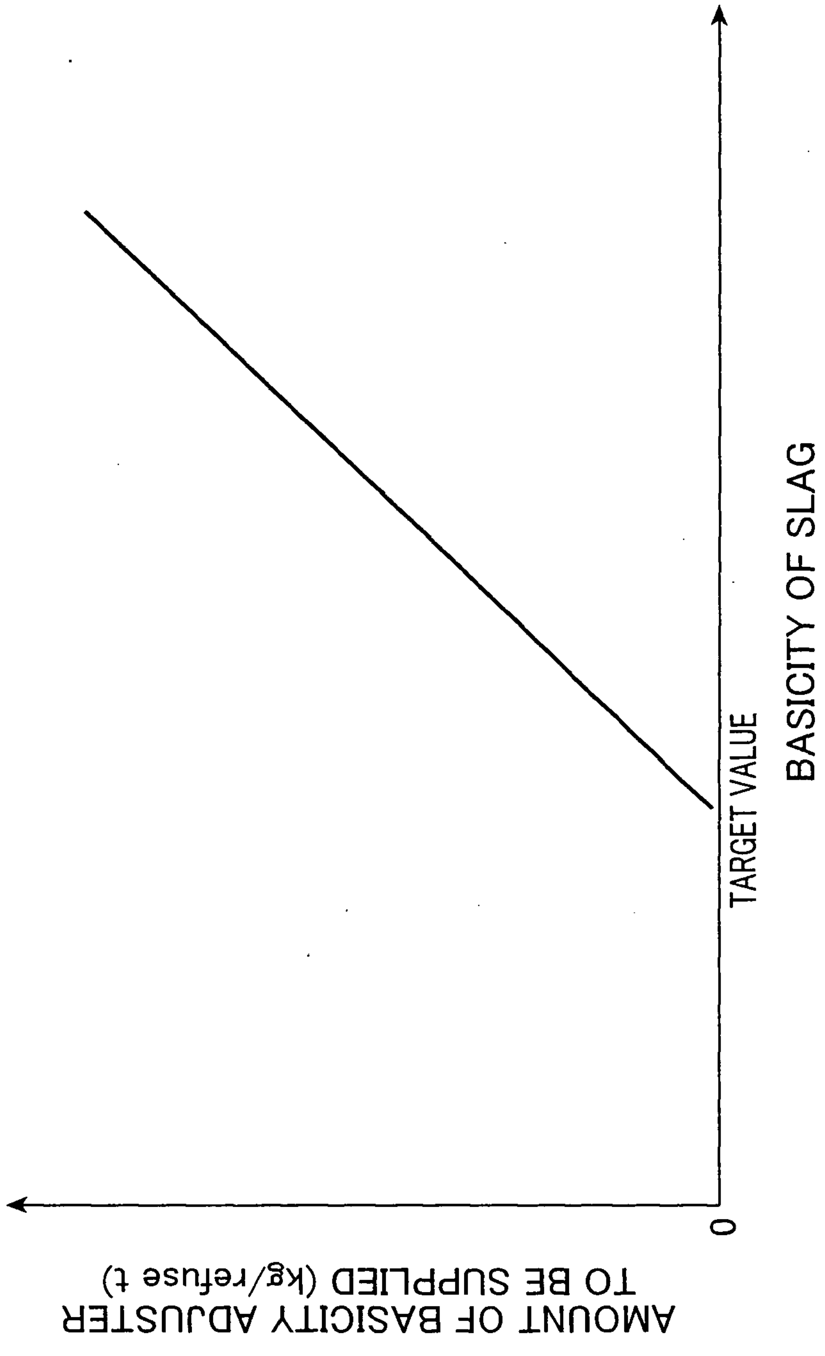

PLANT A
PLANT B
0.60
BASICITY OF SLAG
CALORIFIC VALUE OF REFUSE (kcal/kg)

FIG.11


AMOUNT OF BASICITY ADJUSTER
TO BE SUPPLIED (kg/refuse t)
0
TARGET VALUE
BASICITY OF SLAG

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/067003

A. CLASSIFICATION OF SUBJECT MATTER
F23G5/50(2006.01)i, *F23G5/00*(2006.01)i, *F23G5/027*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F23G5/50, F23G5/00, F23G5/027

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2007
Kokai Jitsuyo Shinan Koho	1971-2007	Toroku Jitsuyo Shinan Koho	1994-2007

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2004-353944 A (Hitachi Zosen Corp.), 16 December, 2004 (16.12.04), Full text (Family: none)	3,9,12 5,10,
Y	JP 2003-302023 A (Ebara Corp.), 24 October, 2003 (24.10.03), Par. No. [0024] (Family: none)	5,10,
Y	JP 2006-349218 A (Kobelco Eco-Solutions Co., Ltd.), 28 December, 2006 (28.12.06), Claims 1, 3 (Family: none)	13-18

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 November, 2007 (06.11.07)	13 November, 2007 (13.11.07)

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

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/067003

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 6-159640 A (Ebara Infiruko Kabushiki Kaisha), 07 June, 1994 (07.06.94), Par. Nos. [0019] to [0044] (Family: none)	13-18
Y	JP 2004-037049 A (Kobe Steel, Ltd.), 05 February, 2004 (05.02.04), Par. Nos. [0023] to [0028] (Family: none)	13-18

Form PCT/ISA/210 (continuation of second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/067003

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The inventions of claims 1 to 12 relate to stop and reignition of an auxiliary burner provided in a melting furnace constituting a gasification melting furnace, and the inventions of claims 13 to 18 relate to the adjustment of a basicity of a melt in a gasification melting furnace.

Further, there is no common technical feature (a technical feature that defines a contribution which makes over the prior art) between these inventions.

Thus, there is no technical relationship between the inventions of claims 1 to 12 and the inventions of claims 13 to 18 involving one or more of the same or corresponding special technical features, so that they are not considered as being so linked as to form a single general inventive concept.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest the

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

Form PCT/ISA/210 (continuation of first sheet (2)) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2006029678 A **[0012]**
- JP 2001182924 A **[0012]**
- JP 2004037049 A **[0044]**