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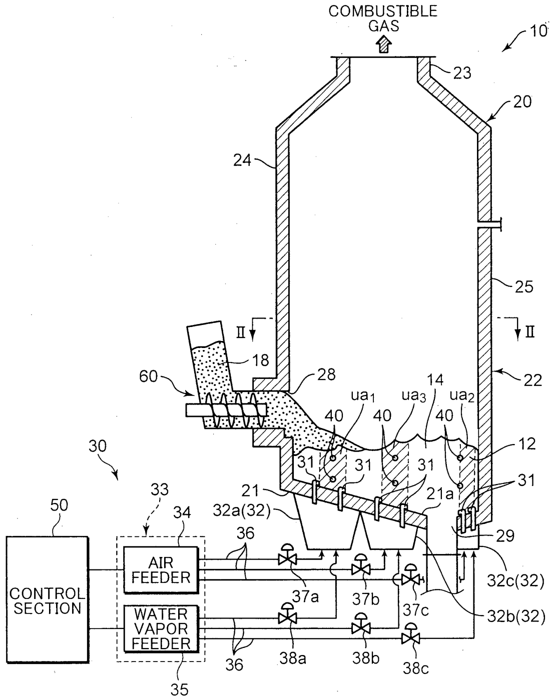
(54) **FLUIDIZED BED FURNACE**

(57) The present invention provides a fluidized bed furnace for heating waste to extract a combustible gas from the waste. The fluidized bed furnace is characterized in that it comprises: a plurality of wind boxes arranged on a lower side of a bottom wall of a furnace body to blow a fluidizing gas into the fluidized bed; a plurality of temperature detection sections disposed at respective positions allowing detection of temperatures of an upper position and a lower position which are vertically spaced in a first region, and allowing detection of temperatures of an upper position and a lower position which are vertically spaced in a second region; and a control section operable, based on the temperatures detected by the temperature detection sections, to adjust an air ratio of the fluidizing gas to be fed to each of the wind boxes, in such a manner that the temperature of the fluidized bed is raised in a direction from the first region toward the second region.

FIG.1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a fluidized bed furnace designed to heat waste in a fluidized bed formed by fluidizing fluidizable particles to thereby extract a combustible gas from the waste.

BACKGROUND ART

[0002] Heretofore, there has been known a fluidized bed furnace described in the following Patent Document 1. As illustrated in FIG. 5, this fluidized bed furnace comprises a furnace body 104 having fluidizable sand (fluidizable particles) 102 in a furnace bottom section, and an air supply section 106 for supplying air into the fluidizable sand 102 in the furnace bottom section so as to fluidize the fluidizable sand 102 to form a fluidized bed. The furnace body 104 has a sidewall. The sidewall is provided with an input section 108 for inputting waste onto the fluidized bed therefrom.

[0003] In this fluidized bed furnace 100, the air supply section 106 is adapted to supply air into high-temperature fluidizable sand 102 to thereby fluidize the fluidizable sand 102 in a fluidizing state. Consequently, a fluidized bed is formed in fluidized bed furnace 100. The air supply section 106 is operable to supply air in such a manner that a fluidized state of the fluidizable sand 102 becomes approximately equalized in the entire region of the fluidized bed so as to allow waste input from the input section 108 onto the fluidized bed to be entrapped inside the fluidized bed and efficiently combusted.

[0004] Every time waste is input from the input section 108 onto the high-temperature fluidizable sand 102, the input waste is mixed with the high-temperature fluidizable sand 102 of the fluidized bed, and thermally decomposed (gasified). Consequently, a combustible gas is generated. For example, this combustible gas will be combusted at high temperatures in a melting furnace in a subsequent stage.

[0005] Waste input into the fluidized bed furnace 100 is entrapped in the active fluidized bed and combusted or gasified. In this process, every time waste is intermittently input, combustible substances in the waste are rapidly combusted, so that a rapid fluctuation in amount, concentration, etc., of a generated combustible gas will repeatedly occur. A change in the gasification reaction is largely dependent on a quantitative characteristic in supply of waste. Thus, in the case where there is a fluctuation in supply of waste or a qualitative change in components of waste, it is impossible to stably generate a combustible gas. Particularly, when a large amount of easily combustible trash such as paper or sheet-shaped plastic is comprised in waste, a fluctuation of generation of a combustible gas becomes larger, and therefore there is a need for stabilizing the gas generation.

[0006] For example, in the case where generated combustible gas is used for a gas engine to generate electric power, if a combustible gas is generated with large fluctuations, it is impossible to obtain stable energy. Therefore, there is a need for further stabilizing a combustible gas to be obtained in a fluidized bed furnace.

LIST OF PRIOR ART DOCUMENTS

[PATENT DOCUMENTS]

[0007] Patent Document 1: JP 2006-242454A

SUMMARY OF THE INVENTION

[0008] It is an object of the present invention to provide a fluidized bed furnace capable of stably obtaining a combustible gas even from waste comprising easily combustible trash.

[0009] The fluidized bed furnace according to the present invention is designed to heat waste to extract a combustible gas from the waste. The fluidized bed furnace comprises: a furnace body having a bottom wall which supports fluidizable particles from therebelow so as to make up a fluidized bed for heating the waste, and a sidewall standing upwardly from the bottom wall, wherein the bottom wall has a discharge port provided at a position offset from a center position of the bottom wall in a specific direction to discharge non-combustible substances in the waste together with a part of the fluidizable particles, and an upper surface of the bottom wall is inclined to become lower toward the discharge port so as to cause the non-combustible substances to fall on the upper surface of the bottom wall toward the discharge port; a gas supply section for blowing a fluidizing gas from the bottom wall of the furnace body toward the fluidizable particles to fluidize the fluidizable particles; a plurality of temperature detection sections for detecting a temperature of the fluidized bed; a control section for controlling the gas supply section; and a waste supply section for supplying waste from a supply-side portion of the sidewall located on a side opposite to the discharge port across the center position of the bottom wall, to a region on the fluidized bed, the region being adjacent to the supply-side sidewall portion. The gas supply section includes a plurality of wind boxes each of which is provided on a lower side of the bottom wall to extend in a direction orthogonal to a direction from the supply-side sidewall portion toward the discharge port and adapted to blow the fluidizing gas from a given position in the orthogonal direction toward the fluidizable particles, and a feeding unit adapted to feed the fluidizing gas to each of the wind boxes in a manner capable of adjusting an air ratio of the fluidizing gas to be fed to each of the wind boxes, individually. The plurality of wind boxes are arranged side-by-side in the direction from the supply-side sidewall portion toward the discharge port. The plurality of temperature detection sections are disposed at respective positions allowing detection of temperatures of an upper position and a lower position which are vertically spaced in a first region of the fluidized bed, the first region vertically overlapping with a first one of the wind boxes closest to the supply-side sidewall portion, and allowing detection of temperatures of an upper position and a lower position which are vertically spaced in a second region of the fluidized bed, the second region vertically overlapping with the discharge port or a second one of the wind boxes closest to the discharge port. The control section is operable, based on the temperatures detected by the temperature detection sections, to adjust an air ratio of the fluidizing gas to be fed from the feeding unit to each of the wind boxes, individually, in such a manner that the temperature of the fluidized bed is raised in a direction from the first region toward the second region.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

FIG. 1 is a schematic configuration diagram of a fluidized bed furnace according to one embodiment of the present invention.
FIG. 2 is a horizontal sectional view taken along the line II-II in FIG. 1.
FIG. 3 is a diagram for explaining upward regions and an arrangement of temperature sensors, in a fluidized bed of the fluidized bed furnace.
FIG. 4 is a diagram for explaining an arrangement of temperature sensors in a fluidized bed furnace according to another embodiment of the present invention.
FIG. 5 is a schematic configuration diagram of a conventional fluidized bed furnace.

DESCRIPTION OF EMBODIMENTS

[0011] With reference to the accompanying drawings, the present invention will now be described based on one embodiment thereof.

[0012] A fluidized bed furnace (fluid bed furnace) according to this embodiment is designed to heat waste by high-temperature fluidizable particles (fluidizable sand), to extract a combustible gas from the waste. For example, waste as a target substance to be treated by the fluidized bed furnace includes wood-based biomasses (pruned branch, lumber, etc.) and combustible substances (plastic, fluff, paper, etc.), and mixture thereof.

[0013] As illustrated in FIGS. 1 and 2, the fluidized bed furnace comprises: a furnace body 20 internally having fluidizable particles 12 making up a fluidized bed 14; a gas supply section 30 for supplying a fluidizing gas to an inside of the furnace body 20, a plurality of temperature sensors (temperature detection sections) 40 for detecting a temperature of the fluidized bed 14, a control section 50 for controlling the gas supply section 30, and a waste supply section 60 for supplying waste 18 into the furnace body 20.

[0014] The fluidizable particles 12 make up the fluidized bed 14 to heat waste 18, inside the furnace body 20. More specifically, the fluidizable particles 12 heated up to a high temperature by combustion of a part of previously supplied waste 18 are mixed with new waste 18, so that the new waste 18 is gasified to generate a combustible gas. For example, the fluidizable particles 12 may be silica sand.

[0015] The furnace body 20 is designed to extract a combustible gas from waste 18 by means of the high-temperature fluidizing particles 12. The furnace body 20 has a bottom wall 21 supporting the fluidizable particles 12 from therebelow, a sidewall 22 standing upwardly from the bottom wall 21, and a combustible gas outlet portion 23 provided at an upper end of the sidewall 22.

[0016] The sidewall 22 has a rectangular tubular shape extending in an up-down (vertical) direction. Specifically, the sidewall 22 has a front wall (supply-side sidewall portion) 24 and a rear wall 25 which are disposed in opposed and spaced-apart relation to each other in a front-rear direction (in FIG. 2, in a right-left direction), and a pair of lateral walls 26, 26 each connecting corresponding ends of the front wall 24 and the rear wall 25. The lateral walls 26, 26 are disposed parallel to each other. In other words, the furnace body 20 has a shape in plan view, in which a dimension in a width direction (widthwise dimension) as a distance between the lateral walls 26, 26 is equalized in the front-rear direction.

[0017] A portion (front wall) 24 of the sidewall 22 located on a side opposite to an aftermentioned discharge port 29 across a center position of the bottom wall 21 has a waste introduction port 28 for introducing waste 18 into the furnace body 20. In this embodiment, as illustrated in FIG. 2, the term "front-rear direction" means a front-rear direction of the furnace body 20 (in FIG. 2, a right-left direction), and the term "width direction" means a width direction of the furnace body 20 (in FIG. 2, an up-down direction).

[0018] The waste introduction port 28 is provided in a central region of a lower portion of the front wall 24 in the width direction. The waste introduction port 28 is provided at a height position where waste 18 can be pushed generally horizontally onto an upper surface of the fluidizable particles 12 (fluidized bed 14) supported by the bottom wall 21 of the furnace body 20. More specifically, the waste introduction port 28 is provided in such a manner that a lower end thereof is located at a position slightly above the upper surface of the fluidized bed 14.

[0019] The combustible gas outlet portion 23 is designed to discharge combustible gas generated inside the furnace body 20. The combustible gas outlet portion 23 has an outer diameter squeezed more than the sidewall 22, so that a duct or the like for supplying the combustible gas obtained in the furnace body 20 to a subsequent stage, for example, a gas engine for electric power generation processes, can be connected thereto.

[0020] The bottom wall 21 has a discharge port 29 provided at a position offset from the center position thereof in a specific direction to discharge non-combustible substances in waste 18 together with a part of the fluidizable particles 12. The discharge port 29 has an opening located in a widthwise central region of the bottom wall 21 at the offset position. The bottom wall 21 has an upper surface 21a inclined to become lower toward the discharge port 29. This allows non-combustible substances and others to fall on the upper surface 21 a. In this embodiment, the upper surface 21a of the bottom wall 21 is divided into a region 211 on a front side (in FIG. 2, left side) of the discharge port 29, a region 212 on a rear side (in FIG. 2, right side) of the discharge port 29, and two regions 213, 214 on widthwise both sides of the discharge port 29. Each of the regions 211, 212, 213, 214 is an inclined surface having a constant downward slope toward the discharge port 29. In other words, the discharge port 29 is provided in the upper surface 21 a of the bottom wall 21 at its downmost position.

[0021] The gas supply section 30 is designed to blow a fluidizing gas from the bottom wall 21 toward the fluidizable particles 12 to fluidize the fluidizable particles 12. The gas supply section 30 comprises a plurality of nozzles 31 installed to the bottom wall 21, a plurality of wind boxes 32 for distributing the fluidizing gas to the respective nozzles 31, and a feeding unit 33 for feeding the fluidizing gas to each of the wind boxes 32. In this embodiment, in the bottom wall 21, two or more of the plurality of nozzles 31 are arranged in a row in the width direction, and a plurality of the widthwise rows of nozzles 31 are arranged side-by-side in the front-rear direction. In other words, the plurality of nozzles 31 are installed to the bottom wall 21 in spaced-apart relation to each other in the width direction and the front-rear direction, i.e., in a lattice arrangement. Each of the nozzles 31 is attached to the bottom wall 21 to penetrate through the bottom wall 21. It is to be understood that a layout of the nozzles 31 is not limited to the lattice arrangement.

[0022] Each of the wind boxes 32 is designed to allow the fluidizing gas to be blown from given widthwise positions of the bottom wall 21 to the inside of the furnace body 20 via one or more of the rows of nozzles 31. The wind box 32 has a box shape capable of being installed on a lower side of the bottom wall 21 in such a manner as to extend in the width direction. The wind box 32 serves as a header for distributing the fluidizing gas to the corresponding one or more rows of nozzles 31 arranged in the width direction in the bottom wall 21. In other words, the wind box 32 has a function of equalizing respective flow rates of the fluidizing gas to be blown from the corresponding one or more rows of nozzles 31 arranged in the width direction. In this embodiment, a common fluidizing gas is distributed from each of the wind boxes 32 to two of the rows of nozzles 31 located adjacent to each other in the front-rear direction.

[0023] The plurality of wind boxes 32 are provided on the side of a lower surface of the bottom wall 21 and arranged side-by-side in the front-rear direction. Thus, with respect to each group of the two rows of nozzles 31 corresponding to a respective one of the wind boxes 32, a composition and/or a flow rate of the fluidizing gas to be blown from the two rows of nozzles 31 can be changed. In this embodiment, three wind boxes 32a, 32b, 32c are arranged side-by-side in the front-rear direction. Specifically, two wind boxes (a first wind box 32a and a second wind box 32b) are disposed on the side of the front wall 24 with respect to the discharge port 29, and one wind box (a third wind box 32c) is disposed on the side of the rear wall 25 with respect to the discharge port 29.

[0024] The feeding unit 33 comprises an air feeder 34 for feeding air (oxygen), a steam feeder 35 for feeding steam, and a plurality of pipe lined 36 connecting each of the feeders 34, 35 to the wind boxes 32. The feeding unit 33 is adapted to feed air and steam from respective ones of the feeders 34, 35 to the wind boxes 32 via the pipe lines 36, individually. In this embodiment, the fluidizing gas is composed of air and/or steam fed from the air feeder 34 and/or the steam feeder 35 to each of the wind boxes 32.

[0025] Each of the pipe lines 36 is provided with a respective one of a plurality of valves 37a, 37b, 37c, 38a, 38b, 38c to adjust a flow rate of fluid (in this embodiment, air or steam) flowing through the pipe line 36. Each of the valves 37a, 37b, 37c, 38a, 38b, 38c is adapted to change a degree of valve opening, according to a control signal from the control section 50. This allows adjustment of an air/fuel ratio (oxygen concentration) of the fluidizing gas to be supplied from the wind boxes 32 into the inside of the furnace body 20.

[0026] Each of the plurality of temperature sensors 40 is designed to detect a temperature of the fluidized bed 14. The plurality of temperature sensors 40 are provided inside the furnace body 20. Each of the temperature sensors 40 is connected to the control section 50 and operable to convert a detected temperature to a temperature signal and input the temperature signal into the control section 50.

[0027] The temperature sensors 40 are allocated in a plurality of regions ua_1, ua_2, ua_3 of the fluidized bed vertically overlapping with respective ones of the wind boxes 32 (each of the regions will hereinafter be referred to as "upside region"). Specifically, the temperature sensors 40 are arranged to allow detection of temperatures of an upper position and a lower position which are vertically spaced in each of the upside regions ua_1, ua_2, ua_3. In this embodiment, a total number six of temperature sensors 40 are provided. More specifically, three sets of two temperature sensors 40 are allocated, respectively, in the upside region (first region) ua_1 of the first wind box 32a, the upside region (third region) ua_3 of the second wind box 32b, and the upside region (second region) ua_2 of the third wind box 32c. In this embodiment, the three wind boxes 32 are provided in the furnace body 20, and therefore the number of the upside regions ua_1, ua_2, ua_3 is three. It is to be understood that when the number of the wind boxes 32 is increased, the number of the upside regions is increased in proportion thereto. Further, the term "upper position" means a position above a center of the fluidized bed 14 in the vertical direction. The term "lower position" means a position below the center of the fluidized bed 14. In this regard, however, the upper position is located at a given depth or more so as to become insusceptible to a gas temperature and a waste temperature above the upper surface of the fluidized bed 14. The lower position is located above the upper surface 21 a of the bottom wall 21 by a given distance or more so as to become insusceptible to a temperature of the bottom wall 21 itself.

[0028] The two temperature sensors 40 allocated in each of the upside regions ua_1, ua_2, ua_3 are not necessarily arranged at vertically overlapping positions, as long as they can detect respective temperatures of the upper position and the lower position in the upside region (ua_1, ua_2, ua_3). In other words, one of the two temperature sensors 40 for detecting the temperature of the upper position and the other temperature sensor 40 for detecting the temperature of the lower position may be arranges at respective positions offset in the width direction in the upside region (ua_1, ua_2, ua_3) (see FIG. 2). Alternatively or additionally, the one temperature sensor 40 for detecting the temperature of the upper position and the other temperature sensor 40 for detecting the temperature of the lower position may be arranged at respective positions offset in the front-rear direction in the upside region (ua_1, ua_2, ua_3) (more specifically, in a region between a blowout port row of a front one of the two rows of nozzles 31 and a blowout port row of a rear one of the two rows of nozzles 31 (see each shaded area in FIG. 3)).

[0029] As long as the temperature sensors 40 are arranged to allow the temperatures of the upper position and the lower position to be detected in each of the first region ua_1 and the second region ua_2, the number of the temperature sensors 40 in each of the remaining one or more upside regions (in this embodiment, the third region ua_3) may be one. Alternatively, the number of the temperature sensors 40 to be allocated in each of the upside regions ua_1, ua_2, ua_3 may be three or more.

[0030] It is to be understood that, as long as the temperature sensors 40 are arranged to allow the temperatures of the upper position and the lower position to be detected at least in each of the first region ua_1 and the second region ua_2, a total number and an arrangement of the temperature sensors 40 to be provided inside the furnace body 20 are not limited to a specific number or specific positions.

[0031] For example, the number of the temperature sensors 40 to be allocated between the first region ua_1 and the second region ua_2 may be one. In another example, specific ones of the plurality of temperature sensors 40 may be arranged at respective positions allowing detection of temperatures at given intervals in the front-rear direction (e.g., arranged in the front-rear direction in a row when viewed in the width direction (see FIG. 4)). In this case, the specific temperature sensors 40 may be arranged in each of one or more upside regions (in this embodiment, the third region ua_3) located between the first region ua_1 and the second region ua_2, or may be arranged at given intervals in the front-rear direction, irrespective of the upside regions ua_1, ua_2, ua_3. This arrangement makes it possible to detect temperatures between the first region ua_1 and the second region ua_2 in the fluidized bed 14, thereby detecting local temperature abnormality of the fluidized bed 14, e.g., a local lowering in temperature between the first region ua_1 and the second region ua_2.

[0032] Preferably, the specific temperature sensors 40 are arranged at respective positions additionally allowing detection of temperatures of an upper position and a lower position in each of the one or more upside regions (ua_3) between the first region ua_1 and the second region ua_2. Based on arranging the specific temperature sensors 40 in this manner, it becomes possible to desirably detect defective fluidization in the one or more upside regions (ua_3) between the first region ua_1 and the second region ua_2 of the fluidized bed 14. Specifically, in a situation where, when the fluidizing gas is supplied from the bottom wall 21 into the fluidized bed 14, the fluidizable particles 12 in a region supplied with the fluidizing gas is in a sufficiently fluidized state, the supplied fluidizing gas will easily move upwardly through the fluidized bed 14. However, if defective fluidization occurs in the region ua, the fluidizing gas becomes hard to move upwardly through the fluidized bed 14. Thus, in and around the region having the defective fluidization, the fluidizable particles 12 are not sufficiently agitated. This causes a temperature difference between an upper position and a lower position in this region, so that this temperature difference is detected to detect the defective fluidization in this region.

[0033] The control section 50 is operable, based on the temperatures detected by the temperature sensors 40, to adjust an air ratio of the fluidizing gas to be fed from the feeding unit 33 to each of the wind boxes 32, individually. More specifically, the control section 50 is operable to adjust an air ratio of the fluidizing gas to be fed to each of the wind boxes 32 by controlling the feeding unit 33 in such a manner that a temperature of the fluidized bed 14 is raised toward a rear side (i.e., in a direction from the front wall 24 toward the rear wall 25). This makes it possible to suppress a rapid fluctuation in amount, concentration, etc., of a combustible gas to be generated in the fluidized furnace 10. As a result, the fluidized furnace 10 can stably generate a combustible gas from waste 18.

[0034] The control section 50 is also operable, based on the temperatures detected by the temperature sensors 40, to detect fluidization abnormality (local defective fluidization, etc.) and control a gas feeding section 30 to an air ratio and/or a flow rate of the fluidizing gas to be supplied to the inside of the furnace body 20. This makes it possible to solve the fluidization abnormality.

[0035] Specifically, the control section 50 is configured to control respective temperatures of the regions of the fluidized bed 14 in the front-rear direction in the following manner (first method). In this embodiment, assume that the three sensors 40 on an upper side in FIG. 1 are defined as a first sensor, a second sensor and a third sensor in order from the left side, and the three sensors 40 on a lower side in FIG. 1 are defined as a fourth sensor, a fifth sensor and a sixth sensor in order from the left side, wherein a temperature detected by the first sensor, a temperature detected by the second sensor, a temperature detected by the third sensor, a temperature detected by the fourth sensor, a temperature detected by the fifth sensor and a temperature detected by the sixth sensor are represented as T_1, T_2, T_3, T_4, T_5 and T_6, respectively.

[0036] In response to receiving temperature signals from the temperature sensors 40, the control section 50 acquires temperatures in each of the regions (regions in which the temperature sensors 40 are allocated) of the fluidized bed 14, and calculates an average value Ave1 of T_1 and T_4, an average value Ave2 of T_2 and T_5 and an average value Ave3 of T_3 and T_6. Then, the control section 50 compares the averages Ave1, Ave2 and Ave3.

[0037] When the relation "Ave1 < Ave2 < Ave3" is broken, the control section 50 instructs the feeding unit 33 to temporarily increase a flow rate of the fluidizing gas to be supplied to each of the wind boxes 32. In this regard, although the control section 50 in this embodiment is configured to continually monitor the relation "Ave1 < Ave2 < Ave3", it may be configured to monitor the relation "Ave1 <Ave2 < Ave3" at intervals of a given time.

[0038] More specifically, when the control section 50 detects temperature abnormality in response to a change to "Ave1 > Ave2" or "Ave2 > Ave 3", it operates to increase the flow rate of the fluidizing gas to be fed to the wind boxes 32. During this process, the control section 50 operates to increase only the flow rate of the fluidizing gas to be blown from each of the wind boxes 32 to the inside of the furnace body 20, while keeping a ratio between air and vapor to be fed to each of the wind boxes 32 (i.e., air ratio of the fluidizing gas) at a constant value. Specifically, upon detection of the temperature abnormality, the control section 50 operates to temporarily increase the flow rate of the fluidizing gas to be blown from each of the wind boxes 32 into the fluidized bed 14, from a normal flow rate (e.g., Uo/Umf = 3.0) (for example, an increased flow rate Uo/Umf = 5.0). In the above description, Umf is a minimum fluidization velocity which is a minimum flow velocity of the fluidizing gas to be blown so as to fluidize the fluidizable particles 12, and Uo is a cross-sectional average flow velocity of the fluidizing gas.

[0039] Then, when temperatures detected by the temperature sensors 40 satisfy the relation "Ave1 < Ave2 < Ave3", the control section 50 controls the feeding unit 33 to return the flow rate of the fluidizing gas to be blown from each of the wind boxes 32 into the fluidized bed 14, to an original value (in the above example, return the Uo/Umf from 5.0 to 3.0), and continues the temperature monitoring. On the other hand, in a situation where the temperatures detected by the temperature sensors 40 do not satisfy the relation "Ave1 <Ave2 < Ave3" even when a certain time has elapsed after starting to increase the flow rate of the fluidizing gas, the control section 50 determines that abnormality occurs in the inside of the furnace body 20. Then, the control section 50 stops an operation of the fluidized bed furnace 10.

[0040] More specifically, for example, in a normal operation state of the fluidized bed furnace 10 where no temperature abnormality occurs in the fluidized bed 14, Ave1, Ave2 and Ave3 are about 600°C, about 650°C and about 700°C, respectively. Assume that this Ave1 is increased to 660°C due to a change in amount and/or composition of waste 18 supplied to the inside of the furnace body 20. In this situation, in response to detection of temperature abnormality (Ave1 > Ave2), the control section 50 operates to temporarily increase the flow rate of the flow rate of the fluidizing gas to be blown from each of the wind boxes 32 into the fluidized bed 14. Thus, while the Ave1, the Ave2 and the Ave3 are increased, respectively, to 700°C, 750°C and 800°C, and the temperature of the fluidized bed 14 is raised in its entirety, the local defective fluidization, etc., of the fluidized bed 14, is solved, and a temperature balance of the inside of the furnace is recovered. Consequently, the temperatures detected by the temperature sensors 40 start satisfying the relation "Ave1 < Ave2 < Ave3". Subsequently, when the control section 50 operates to return the flow rate of the fluidizing gas to be blown from each of the wind boxes 32 into the fluidized bed 14, to the original value, the Ave1, the Ave2 and the Ave3 are returned to about 600°C, about 650°C and about 700°C, respectively, and the temperature abnormality occurring in the fluidized bed is solved.

[0041] In this method, the control section 50 may be configured to, in a situation where, although the temperatures detected by the temperature sensors 40 satisfy the relation "Ave1 < Ave2 < Ave3", Ave1 and Ave3 are deviated, respectively, from their given ranges (min_1 < Ave1 < max_1 and min_3 < Ave3 < max_3), temporarily increase the flow rate of the fluidizing gas to be blown from each of the wind boxes 32 into the fluidized bed 14. Thus, the control section 50 can more desirably maintain a temperature distribution of the fluidized bed in the front-rear direction (i.e., a temperature distribution in which the temperature of the fluidized bed 14 is gradually raised in the direction from the front wall 24 toward the rear wall 25).

[0042] Alternatively, the control section 50 may be configured to control respective temperatures of the regions of the fluidized bed 14 in the front-rear direction in the following manner (second method).

[0043] The control section 50 operates to monitor the relation "Ave1 < Ave2 < Ave3", in the same manner as that in the aforementioned method. Specifically, in response to receiving temperature signals from the temperature sensors 40, the control section 50 acquires temperatures in each of the regions of the fluidized bed 14 and calculates average values Ave1, Ave2, Ave3 thereof. Then, the control section 50 compares the averages

Ave1, Ave2 and Ave3. In this method, the control section 50 may be configured to continually monitor the relation "Ave1 <Ave2 < Ave3", or may be configured to monitor the relation "Ave1 <Ave2 < Ave3" at intervals of a given time.

[0044] When the relation "Ave1 < Ave2 < Ave3" is broken, the control section 50 instructs the feeding unit 33 to adjust a ratio between air and vapor to be fed to one of the wind boxes 32 corresponding to an abnormal one of the regions. For example, when high-temperature abnormality occurs in the first region ua_1 to cause the relation "Ave1 > Ave2", the control section 50 controls the feeding unit 33 to close the valve 37a to reduce a flow rate of air to be fed to the first wind box 32 and open the valve 38a to increase a flow rate of steam to be fed to the first wind box 32, while keeping a flow rate of the fluidizing gas to be blown from the first wind box 32 into the fluidized bed 14. Thus, an air ratio of the fluidizing gas to be blown from the first wind box 32 into the fluidized bed 14 becomes smaller. In other words, an oxygen concentration is lowered. Subsequently, the control section 50 continues the temperature monitoring, and, when the relation "Ave1 < Ave2" is satisfies, operates to return the valves 37a, 38a, respectively, to their original positions (i.e., open the valve 37a and close the valve 38a) to return the air ratio (oxygen concentration) of the fluidizing gas to be blown from the first wind box 32 into the fluidized bed 14, to an original value. On the other hand, in a situation where the temperatures still have the relation "Ave1 > Ave2" even when a given time has elapsed after starting to reduce the air ratio of the fluidizing gas to be blown from the first wind box 32 into the fluidized bed 14, the control section 50 determines that abnormality occurs in the inside of the furnace body 20, and stops the operation of the fluidized bed furnace 10.

[0045] In this method, the control section 50 may be configured to, to in a situation where, although the temperatures detected by the temperature sensors 40 satisfy the relation "Ave1 < Ave2 < Ave3", Ave1 and Ave3 are deviated, respectively, from their given ranges (min_1 < Ave1 < max_1 and min_3 < Ave3 < max_3), adjust respective valve openings of the valves 37a, 37c, 38a, 38c (i.e., adjust an air ratio of the fluidizing gas to be blown from the first wind box 32a into the fluidized bed 14 and an air ratio of the fluidizing gas to be blown from the third wind box 32c into the fluidized bed 14) to return the Ave1 and the Ave3, respectively, to the given ranges. Specifically, when low-temperature abnormality occurs in the first region ua_1 of the fluidized bed 14, the control section 50 controls the feeding unit 33 to open the valve 37a and close the valve 38a to increase the air ratio of the fluidizing gas to be blown from the first wind box 32a into the fluidized bed 14, while keeping the flow rate of this fluidizing gas. On the other hand, when high-temperature abnormality occurs in the second region ua_2 of the fluidized bed 14, the control section 50 controls the feeding unit 33 to close the valve 37c and open the valve 38c to reduce the air ratio of the fluidizing gas to be blown from the third wind box 32c into the fluidized bed 14, while keeping the flow rate of this fluidizing gas. Further, when low-temperature abnormality occurs in the second region ua_2 of the fluidized bed 14, the control section 50 controls the feeding unit 33 to open the valve 37c and close the valve 38c to increase the air ratio of the fluidizing gas to be blown from the third wind box 32c into the fluidized bed 14, while keeping the flow rate of this fluidizing gas.

[0046] Further, the control section 50 operates to monitor a local temperature abnormality of the fluidized bed 14 caused when fluidization abnormality of the fluidized bed 14 (local defective fluidization, etc., in the fluidized bed 14) occurs. Then, when temperature abnormality is detected, the control section 50 controls the feeding unit 33 to adjust the air ratio and/or the flow rate of the fluidizing gas to be fed to each of the wind boxes 32, thereby solving the fluidization abnormality of the fluidized bed 14.

[0047] Specifically, in a specific region of the fluidized bed 14 where defective fluidization occurs, the fluidizable particles 12 are not sufficiently agitated because flowability (mobility) of the fluidizing gas in the specific region is different from the remaining region. This causes a temperature difference between an upper side and a lower side of the specific region. Therefore, the control section 50 operates to detect a temperature difference in the specific region to detect local defective fluidization in the fluidized bed 14, i.e., fluidization abnormality of the fluidized bed 14. Upon detection of the defective fluidization (the fluidization abnormality), the control section 50 operates to adjust the flow rate of the fluidizing gas to be supplied to the inside of the furnace body 20.

[0048] More specifically, the control section 50 is configured to control an up-down directional (vertical) temperature in each of the regions of the fluidized bed 14, in the following manner.

[0049] In response to receiving temperature signals from the temperature sensors 40, the control section 50 acquires temperatures in each of the regions (regions in which the temperature sensors 40 are allocated) of the fluidized bed 14. The control section 50 calculates a temperature difference (ΔT_1 (= $T_1 - T_4$), ΔT_2 (= $T_2 - T_5$), ΔT_3 (= $T_3 - T_6$)) between the upper position and the lower position in each of the regions of the fluidized bed 14. Then, the control section 50 compares each of the temperature differences ΔT_1, ΔT_2, ΔT_3 with a predetermined given value to perform monitoring (detection) on whether the local defective fluidization in the fluidized bed 14 occurs. This monitoring may be performed continually or may be performed at intervals of a given time.

[0050] For example, in the case where the given value is set to ± 10°C, when the relation "ΔT_1, ΔT_2 or ΔT_3 > 10°C" or "ΔT_1, ΔT_2 or ΔT_3 < - 10°C" is satisfied, the control section 50 operates to temporarily increase a flow rate of the fluidizing gas to be supplied to the corresponding region. Specifically, when the relation "ΔT_1 < - 10°C" is satisfied, the control section 50 controls the feeding section 33 to temporarily increase a flow rate of the fluidizing gas to be blown from the first wind box 32a into the fluidized bed 14, from a normal flow rate (e.g., Uo/Umf = 3.0) (for example, an increased flow rate Uo/Umf = 5.0). In this process, the control section 50 operates to increase only the flow rate without changing an air ratio of the fluidizing gas. Then, when the relations "$\Delta T_1 > -10°C$" and "$\Delta T_1 < 10°C$" are satisfied, the control section 50 controls the feeding unit 33 to return the flow rate of the fluidizing gas to be blown from the first wind box 32a into the fluidized bed 14, to an original value (e.g., return the Uo/Umf from 5.0 to 3.0), and continues the temperature monitoring. On the other hand, in a situation where the relation "$\Delta T_1 < -10°C$" is still satisfied even when a certain time has elapsed after starting to increase the flow rate, the control section 50 determines that abnormality occurs in the inside of the furnace body 20 and stops the operation of the fluidized bed furnace 10.

[0051] Furthermore, the control section 50 is configured to perform control of the waste supply section 60, etc.

[0052] The waste supply section 60 is designed to supply waste 18 from the front wall 24 to a region on the fluidized bed 14 adjacent to the front wall 24. The waste supply section 60 in this embodiment is a screw extruder. The screw extruder is capable of continuously supply waste 18 to the inside of the furnace while guaranteeing sealing performance. The screw extruder is also capable of supplying trash which is likely to be scattered due to its small bulk specific gravity, such as paper or plastic sheet, to the inside of the furnace body 20 while keeping a massive form. This makes it possible to suppress scattering of trash inside the furnace body 20, as compared to a conventional furnace in which trash is input from an upper portion thereof. It is to be understood that the configuration of the waste supply section 60 is not limited to a specific type. For example, although the waste supply section 60 in this embodiment is configured to push waste 18 into the furnace by using the screw extruder, it may be configured to push waste 18 into the furnace by using a pusher or the like.

[0053] In the fluidized bed furnace 10 configured as above, a combustible gas is recaptured from waste 18 in the following manner.

[0054] At the start of the operation of the fluidized bed furnace, the control section 50 operates to cause the fluidizing gas from each of the wind boxes 32 toward the fluidizable particles 12 supported by the bottom wall 21 inside the furnace body 20. At the start of the operation, there is not any waste 18 on the fluidized bed 14 (if any, an amount thereof is very small), so that the control section 50 instructs a non-illustrated burner or the like to heat the fluidizable particles 12 as a bed material from above the fluidized bed 14. In this process, the control section 50 operates to fluidize the fluidizable particles 12 by supplying only air from each of the wind boxes 32 to the fluidizable particles 12 without blowing steam, and heat the fluidizable particles 12 in the fluidized state. Then, when the entire fluidized bed 14 is heated to a given temperature (e.g., 600°C), the control section 50 instructs the waste supply section 60 to start to input waste 18 into the furnace body 20. In this process, the control section 50 operates to gradually suppress an operation of the burner or the like, and reduce an amount of supply of air, while increasing an amount of addition of steam, to set a ratio therebetween to a given value.

[0055] The air ratio of the fluidizing gas to be blown from each of the wind boxes 32 toward the fluidizable particles 12 is preliminarily derived as a value suitable for operation of the fluidized bed furnace, and stored in the control section 50. In other words, as long as no temperature abnormality occurs in the fluidized bed 14 during the operation of the fluidized bed furnace 10, the control section 50 operates to supply a given amount of air and a given amount of steam to each of the wind boxes 32 without adjusting the valve openings of the valves 37a, 37b, 37c, 38a, 38b, 38c.

[0056] The fluidizable particles 12 are set in the fluidized state in the above manner, so that the fluidized bed 14 is formed inside the furnace body 20. In this state, while respective fluidizing gases to be blown from the wind boxes 32 into the fluidized bed 14 are identical in flow rate, they are different from each other in terms of air ratio. Specifically, the control section 50 operates to adjust the valve openings of the valves 37a, 37b, 37c, 38a, 38b, 38c to allow an air ratio of the fluidizing gas to be fed to the second wind box 32b to become larger than an air ratio of the fluidizing gas to be fed to the first wind box 32a, and allow an air ratio of the fluidizing gas to be fed to the third wind box 32c to become larger than an air ratio of the fluidizing gas to be fed to the second wind box 32b, so as to cause the temperature of the fluidized bed 14 to be raised in the direction from the front wall 24 toward the rear wall 25.

[0057] As above, the control section 50 operates to change the oxygen concentration in each of the regions in the fluidized bed 14 to thereby form a given temperature distribution (i.e., a temperature distribution in which the temperature of the fluidized bed 14 is raised in the direction from the front wall 24 toward the rear wall 25), while setting the flow rate of the fluidizing gas to be blown from each of the wind boxes 32 into the fluidized bed 14, to a constant value, to thereby desirably maintain the fluidized state in each of the regions in the fluidized bed 14.

[0058] When Ave1, Ave2 and Ave3 become about 600°C, about 650°C and about 700°C, respectively, the control section 50 determines that the inside of the furnace is set in a steady state, and starts temperature control. In this embodiment, the control section 50 is configured to perform the temperature control of the fluidized bed 14 to allow a temperature difference between Ave1 and Ave3 to become equal to or greater than 50°C, and allow Ave1 and Ave3 to fall with the range of 600 to 700°C and the range of 700 to 800°C, respectively.

[0059] Specifically, the screw extruder (the waste supply section 60) pushes waste 18 generally horizontally toward the inside of the furnace body 20. Through this operation, the waste 18 is pushed onto the first region ua_1 (see FIGS. 1 and 2). The active fluidized bed 14 is formed inside the furnace body 20. Thus, the input waste 18 is moved from the front wall 24 toward the rear wall 25 while being entrapped by the fluidized bed 14 and spread by a spreading action of the fluidized bed 14. In fact, instead of being moved in only one direction from the front wall 24 toward the rear wall 25, the waste 18 in the fluidized bed 14 is moved from a region having the waste 18 at a relatively high density to a region having the waste 18a at a relatively low density (i.e., from the input side (front wall 24) toward the rear wall 25) in a gradually spreading manner, while repeating reciprocating movements in the up-down, right-left and front-rear directions.

[0060] The first region ua_1 of the fluidized bed 14 has a desirably low temperature. Thus, in the above process, rapid combustion of the waste 18 is suppressed, and easily gasifiable substances in the waste 18 are gasified. In other words, easily gasifiable waste 18 such as plastic or paper is gasified in the first region ua_1 and a region adjacent thereto. On the other hand, not-easily gasifiable waste such as a wood piece is partially gasified, but a large part thereof is gradually moved toward the rear wall 25 according to fluidization of the fluidizable particles, etc., and will reach the second region ua_2 without being gasified. In this manner, the easily gasifiable waste 18 is gasified under a mild condition (low temperature) in the first region ua_1 or the adjacent region (on the side of the second region ua_2) before it reaches the second region ua_2, so that it becomes possible to suppress a fluctuation of generation of a combustible gas.

[0061] Then, the moved waste 18 is sufficiently mixed with the fluidizable particles 12 in a region of the fluidized bed 14 vertically overlapping with the discharge port 29, and a high-temperature region therearound, so that uncombusted waste 18 remaining after passing through the region on the side of the front wall 24 is sufficiently gasified.

[0062] As above, according to the screw extruder 60, waste 18 is continuously supplied to the fluidized bed 14 having a temperature distribution in which the temperature of the fluidized bed 14 is raised in the direction from the front wall 24 toward the rear wall 25, so that it becomes possible to suppress intermittent and rapid generation of a combustible gas. Consequently, the generation of a combustible gas is stabilized.

[0063] The fluidizable particles 12 discharged from the fluidized bed 14 through the discharge port 29 together with non-combustible substances and others are input into the furnace body 20 again, according to need.

[0064] In a situation where abnormality in the temperature distribution of the fluidized bed 14 occurs (i.e., a region having an excessively low or high temperature locally occurs), or fluidization abnormality (i.e., local defective fluidization in the fluidized bed 14, etc.) occurs, due to an amount of input of waste 18, a composition of trash comprised in waste 18, etc., the control section 50 is operable, based on the temperatures detected by the temperature sensors 40, to control the gas feeding section 30 to adjust the flow rate of air and/or the flow rate of steam to be fed to each of the wind boxes 32, as mentioned above. In this way, the control section 50 can solve the temperature distribution abnormality and fluidization abnormality in the fluidized bed 14.

[0065] A combustible gas generated inside the furnace body 20 is supplied from the combustible gas outlet portion 23 to a subsequent stage such as a gas engine for electric power generation processes, via a duct or the like connected to the combustible gas outlet portion 23. In this process, steam included in the combustible gas is condensed into water due to a lowering in temperature of the combustible gas, and the water is collected. Thus, a combustible gas after removal of steam will be supplied to the subsequent stage of the fluidized bed furnace 10.

[0066] As mentioned above, in the fluidized bed furnace 10 according to the above embodiment, waste 18 is supplied from the waste supply section 60 to the side of the first region ua_1 of the fluidized bed 14 whose temperature is raised in the direction from the first region ua_1 toward the second region ua_2, so that it becomes possible to suppress a rapid fluctuation in amount, concentration, etc., of a generated combustible gas. As a result, a combustible gas is stably generated from waste 18.

[0067] Specifically, waste 18 is supplied to the side of the first region ua_1 of the fluidized bed 14 having a desirably low temperature, so that it becomes possible to suppress rapid combustion of easily combustible trash in the waste 18. In addition, an amount of generation of a combustible gas based on gasification of the waste 18 is small. This waste 18 is moved inside the furnace body 20 toward the discharge port 29 (i.e., toward the second region ua_2 of the fluidized bed 14), according to fluidization of the fluidizable particles 12 making up the fluidized bed 14 and supply of new waste 18 into the furnace body 20 by the waste supply section 60. The second region ua_2 has a desirably high temperature, so that the waste 18 moved from the side of the first region ua_1 is sufficiently gasified in the second region ua_2 to generate a combustible gas. This makes it possible to suppress intermittent and rapid generation of a combustible gas, and stabilize the generation of the combustible gas.

[0068] In the above embodiment, respective air ratios of the fluidizing gases to be supplied to the regions of the fluidized bed 14 are adjusted in the direction from the front wall 24 toward the rear wall 25 (or the discharge port 29) to adjust respective temperatures of the regions of the fluidized bed 14. Thus, the fluidization abnormality (local defective fluidization in the fluidized bed 14, etc.) becomes less likely to occur in the fluidized bed 14. In other words, it becomes possible to adjust the air ratio (i.e., oxygen concentration) of the fluidizing gas to be supplied to fluidized bed 14 to thereby adjust the temperature in each of the regions of the fluidized bed 14, while sufficiently ensuring the flow rate of the fluidizing gas to be supplied to each of the regions of the fluidized bed 14 to thereby desirably maintain the fluidized state of the fluidizable particles 12 in each of the regions of the fluidized bed 14. In addition, respective temperatures of the upper and lower positions vertically spaced in each of the first region ua_1, the second region ua_2 and the third region ua_3 are detected, so that, if defective fluidization occurs in one of the regions, the defective fluidization can be reliably detected.

[0069] In the above embodiment, the upper surface 21 a of the bottom wall 21 of the furnace body 20 is inclined to become lower toward the discharge port, so that non-combustible substances, carbides and others sinking down to the bottom wall 21 in the fluidized bed 14 fall on the upper surface 21a of the bottom wall 21 toward the discharge port 29. Thus, the non-combustible substances and others can be easily discharged from the furnace body 20.

[0070] It is to be understood that a fluidized bed furnace of the present invention are not limited to the above embodiment, but various changes and modifications may be made therein without departing from the spirit and scope of the present invention hereinafter defined.

[0071] In addition to the positions for detecting the temperatures of the upper and lower positions, the temperature sensors 40 to be allocated in the upside regions ua_1, ua_2, ua_3 may be additionally disposed at a position for detecting a temperature of an intermediate position between the upper and lower positions.

[0072] In the above embodiment, the temperature sensors 40 are arranged side-by-side at intervals and at the same height, in the front-rear direction. Alternatively, the temperature sensors 40 may be arranged at different heights in respective ones of the upside regions ua_1, ua_2, ua_3.

[0073] In the case where each of two wind boxes on both front and rear sides of the discharge port 29 (in FIG. 3, left and right sides of the discharge port 29) are located adjacent to the discharge port 29, the wind box closest to the discharge port 29 means the two wind boxes. However, in view of desirable temperature control of the entire fluidized bed 14, it is preferable to control the upside region corresponding to one of the wind boxes on a rear (in FIG. 3, right) side of the discharge port 29.

[Outline of Embodiment]

[0074] The outline of the above embodiment is as follows.

[0075] The fluidized bed furnace according to the above embodiment is designed to heat waste to extract a combustible gas from the waste. The fluidized bed furnace comprises: a furnace body having a bottom wall which supports fluidizable particles from therebelow so as to make up a fluidized bed for heating the waste, and a sidewall standing upwardly from the bottom wall, wherein the bottom wall has a discharge port provided at a position offset from a center position of the bottom wall in a specific direction to discharge non-combustible substances in the waste together with a part of the fluidizable particles, and an upper surface of the bottom wall is inclined to become lower toward the discharge port so as to cause the non-combustible substances to fall on the upper surface of the bottom wall toward the discharge port; a gas supply section for blowing a fluidizing gas from the bottom wall of the furnace body toward the fluidizable particles to fluidize the fluidizable particles; a plurality of temperature detection sections for detecting a temperature of the fluidized bed; a control section for controlling the gas supply section; and a waste supply section for supplying waste from a supply-side portion of the sidewall located on a side opposite to the discharge port across the center position of the bottom wall, to a region on the fluidized bed, the region being adjacent to the supply-side sidewall portion. The gas supply section includes a plurality of wind boxes each of which is provided on a lower side of the bottom wall to extend in a direction orthogonal to a direction from the supply-side sidewall portion toward the discharge port and adapted to blow the fluidizing gas from a given position in the orthogonal direction toward the fluidizable particles, and a feeding unit adapted to feed the fluidizing gas to each of the wind boxes in a manner capable of adjusting an air ratio of the fluidizing gas to be fed to each of the wind boxes, individually. The plurality of wind boxes are arranged side-by-side in the direction from the supply-side sidewall portion toward the discharge port. The plurality of temperature detection sections are disposed at respective positions allowing detection of temperatures of an upper position and a lower position which are vertically spaced in a first region of the fluidized bed vertically overlapping with a first one of the wind boxes closest to the supply-side sidewall portion, and allowing detection of temperatures of an upper position and a lower position which are vertically spaced in a second region of the fluidized bed vertically overlapping with the discharge port or a second one of the wind boxes closest to the discharge port. The control section is operable, based on the temperatures detected by the temperature detection sections, to adjust an air ratio of the fluidizing gas to be fed from the feeding unit to each of the wind boxes, individually, in such a manner that the temperature of the fluidized bed is raised in a direction from the first region toward the second region.

[0076] In the present invention, waste is supplied from the waste supply section to the side of the first region of the fluidized bed whose temperature is raised in a direction from the first region toward the second region, so that it becomes possible to suppress a rapid fluctuation in amount, concentration, etc., of a generated combustible gas. As a result, a combustible gas is stably generated from waste.

[0077] Specifically, waste is supplied to the side of the first region of the fluidized bed having a desirably low temperature, so that it becomes possible to suppress rapid combustion of easily combustible trash in the waste.

In addition, an amount of generation of a combustible gas based on gasification of the waste is small. This waste is moved inside the furnace body toward the discharge port (i.e., toward the second region of the fluidized bed), according to fluidization of the fluidizable particles making up the fluidized bed and supply of new waste into the furnace body by the waste supply section. The second region has a desirably high temperature, so that the waste moved from the side of the first region is sufficiently gasified in the second region to generate a combustible gas. This makes it possible to suppress intermittent and rapid generation of a combustible gas, and stabilize the generation of the combustible gas.

[0078] Further, respective air ratios of the fluidizing gases to be supplied to the regions of the fluidized bed are adjusted in the direction from the supply-side sidewall portion toward the discharge port to adjust respective temperatures of the regions of the fluidized bed, so that fluidization abnormality becomes less likely to occur in the fluidized bed. In other words, it becomes possible to adjust the air ratio (i.e., oxygen concentration) of the fluidizing gas to be supplied to fluidized bed to thereby adjust a temperature in each of the regions of the fluidized bed, while sufficiently ensuring a flow rate of the fluidizing gas to be supplied to each of the regions of the fluidized bed to thereby desirably maintain a fluidized state of the fluidizable particles in each of the regions of the fluidized bed.

[0079] In addition, respective temperatures of the upper and lower positions vertically spaced in each of the first region and the second region are detected, so that, if defective fluidization occurs in one of the regions, the defective fluidization can be reliably detected. Specifically, in a situation where, when the fluidizing gas is supplied from the bottom wall into the fluidized bed, the fluidizable particles in a region supplied with the fluidizing gas is in a sufficiently fluidized state, the supplied fluidizing gas will easily move upwardly through the fluidized bed. However, if defective fluidization occurs in the region, the fluidizing gas becomes hard to move upwardly through the fluidized bed. Thus, in the region having the defective fluidization, the fluidizable particles are not sufficiently agitated, which causes a temperature difference between the upper and lower positions. This temperature difference is detected to detect the defective fluidization.

[0080] Further, the upper surface of the bottom wall of the furnace body is inclined to become lower toward the discharge port, so that non-combustible substances sinking down to the bottom wall in the fluidized bed fall on the upper surface of the bottom wall toward the discharge port. Thus, the non-combustible substances can be easily discharged from the furnace body.

[0081] In the fluidized bed furnace according to the above embodiment, specific ones of the plurality of temperature detection sections are allocated between the first region and the second region of the fluidized bed, and wherein the specific temperature detection sections are disposed at respective positions allowing detection of temperatures at given intervals in the direction from the supply-side sidewall portion toward the discharge port.

[0082] According to this feature, temperatures between the first region and the second region can be detected, so that, if temperature abnormality such as local lowering in temperature occurs between the first and second regions, the abnormality can be detected. This makes it possible to cope with the local temperature abnormality.

[0083] In this case, preferably, the specific temperature detection sections allocated between the first region and the second region are disposed at respective positions allowing detection of temperatures in each of one or more regions of the fluidized bed vertically overlapping with respective ones of the remaining one or more wind boxes disposed between the first wind box and the second wind box.

[0084] According to this feature, temperatures in a region of the fluidized bed through which the fluidizing gas supplied from each of the wind boxes passes are detected, so that it becomes possible to facilitate adjustment of the air ratio of the fluidizing gas to be fed to each of the wind boxes.

[0085] Further, in each of the one or more regions between the first region and the second region, and at a position vertically overlapping with respective ones of the remaining one or more wind boxes, the specific temperature detection sections are disposed at respective positions additionally allowing detection of temperatures of an upper position and a lower position which are vertically spaced.

[0086] According to this feature, defective fluidization in each region ranging from the first and second regions in the fluidized bed can be desirably detected.

INDUSTRIAL APPLICABILITY

[0087] As above, the fluidized bed furnace of the present invention is useful for heating waste in a fluidized bed formed by fluidizing fluidizable particles, to extract a combustible gas from the waste, and suited to stably obtain a combustible gas even from waste comprising easily combustible trash.

Claims

1. A fluidized bed furnace for heating waste to extract a combustible gas from the waste, comprising:

a furnace body having a bottom wall which supports fluidizable particles from therebelow so as to make up a fluidized bed for heating the waste, and a sidewall standing upwardly from the bottom wall, wherein the bottom wall has a discharge port provided at a position offset from a center position of the bottom wall in a specific

direction to discharge non-combustible substances in the waste together with a part of the fluidizable particles, and an upper surface of the bottom wall is inclined to become lower toward the discharge port so as to cause the non-combustible substances to fall on the upper surface of the bottom wall toward the discharge port;
a gas supply section for blowing a fluidizing gas from the bottom wall of the furnace body toward the fluidizable particles to fluidize the fluidizable particles;
a plurality of temperature detection sections for detecting a temperature of the fluidized bed;
a control section for controlling the gas supply section; and
a waste supply section for supplying waste from a supply-side portion of the sidewall located on a side opposite to the discharge port across the center position of the bottom wall, to a region on the fluidized bed, the region being adjacent to the supply-side sidewall portion,
wherein:

the gas supply section includes a plurality of wind boxes each of which is provided on a lower side of the bottom wall to extend in a direction orthogonal to a direction from the supply-side sidewall portion toward the discharge port and adapted to blow the fluidizing gas from a given position in the orthogonal direction toward the fluidizable particles, and a feeding unit adapted to feed the fluidizing gas to each of the wind boxes in a manner capable of adjusting an air ratio of the fluidizing gas to be fed to each of the wind boxes, individually, wherein the plurality of wind boxes are arranged side-by-side in the direction from the supply-side sidewall portion toward the discharge port;
the plurality of temperature detection sections are arranged at respective positions allowing detection of temperatures of an upper position and a lower position which are vertically spaced in a first region of the fluidized bed, the first region being vertically overlapping with a first one of the wind boxes closest to the supply-side sidewall portion, and allowing detection of temperatures of an upper position and a lower position which are vertically spaced in a second region of the fluidized bed, the second region being vertically overlapping with the discharge port or a second one of the wind boxes closest to the discharge port; and
the control section is operable to adjust an air ratio of the fluidizing gas to be fed from the feeding unit to each of the wind boxes, individually, based on the temperatures detected by the temperature detection sections, so as to make the temperature of the fluidized bed be raised in a direction from the first region toward the second region.

2. The fluidized bed furnace as defined in claim 1, wherein specific ones of the plurality of temperature detection sections are allocated between the first region and the second region of the fluidized bed, and wherein the specific temperature detection sections are arranged so as to be capable of detecting of temperatures at respective positions at given intervals in the direction from the supply-side sidewall portion toward the discharge port.

3. The fluidized bed furnace as defined in claim 2, wherein the specific temperature detection sections allocated between the first region and the second region are arranged so as to be capable of detecting of temperatures at respective positions in each of one or more regions of the fluidized bed, the regions being vertically overlapping with respective ones of the remaining one or more wind boxes disposed between the first wind box and the second wind box.

4. The fluidized bed furnace as defined in claim 3, wherein, in each of the one or more regions between the first region and the second region, and at a position vertically overlapping with respective ones of the remaining one or more wind boxes, the specific temperature detection sections are arranged so as to be capable of detecting of temperatures at respective positions of an upper position and a lower position which are vertically spaced.

FIG.1

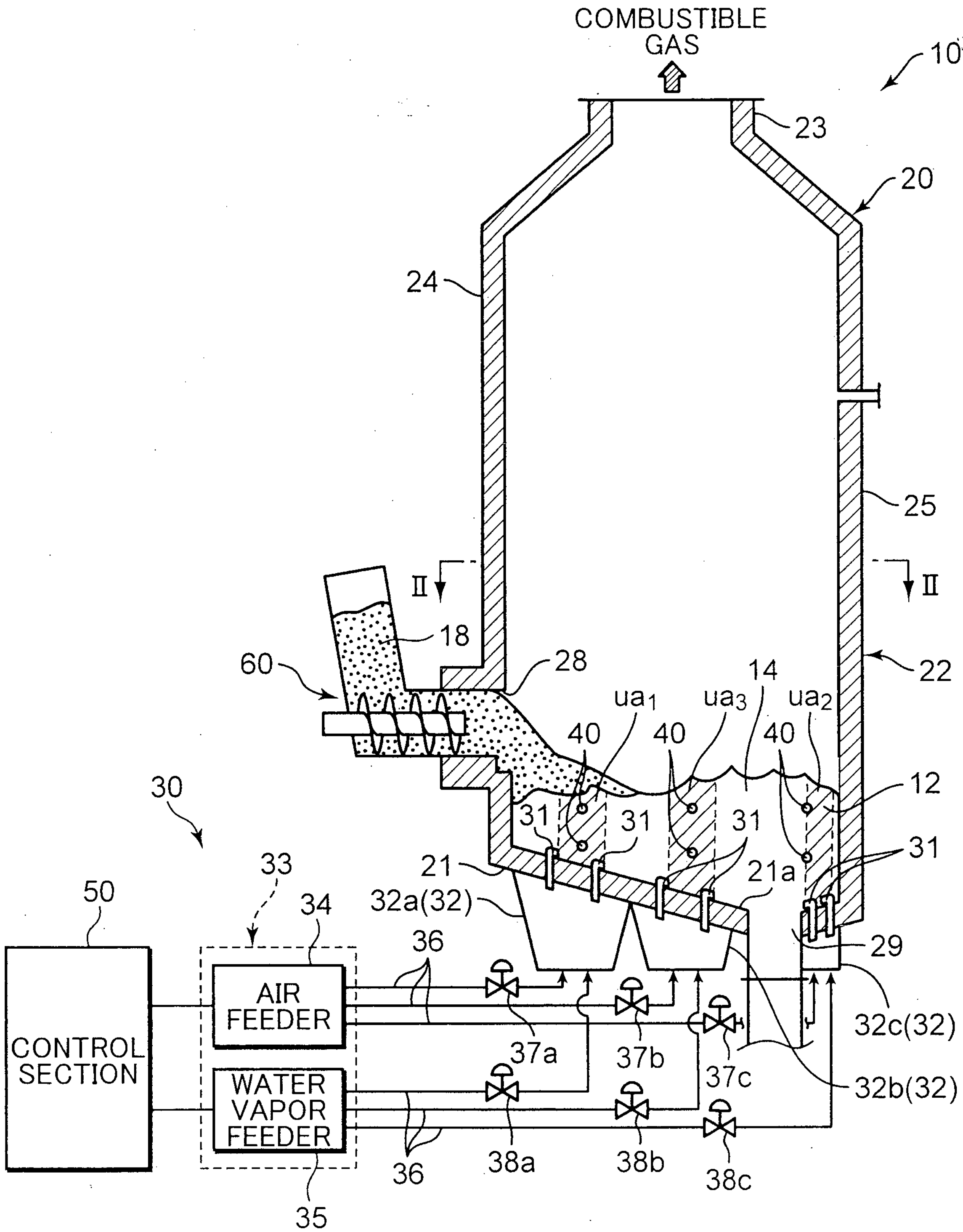

COMBUSTIBLE GAS
10
23
20
24
25
II
II
18
60
28
14
22
ua1
ua3
ua2
40
40
40
12
30
31
31
31
31
33
21
21a
50
34
32a(32)
29
36
AIR FEEDER
32c(32)
CONTROL SECTION
37a
37b
37c
WATER VAPOR FEEDER
32b(32)
38a
38b
38c
36
35

FIG.2

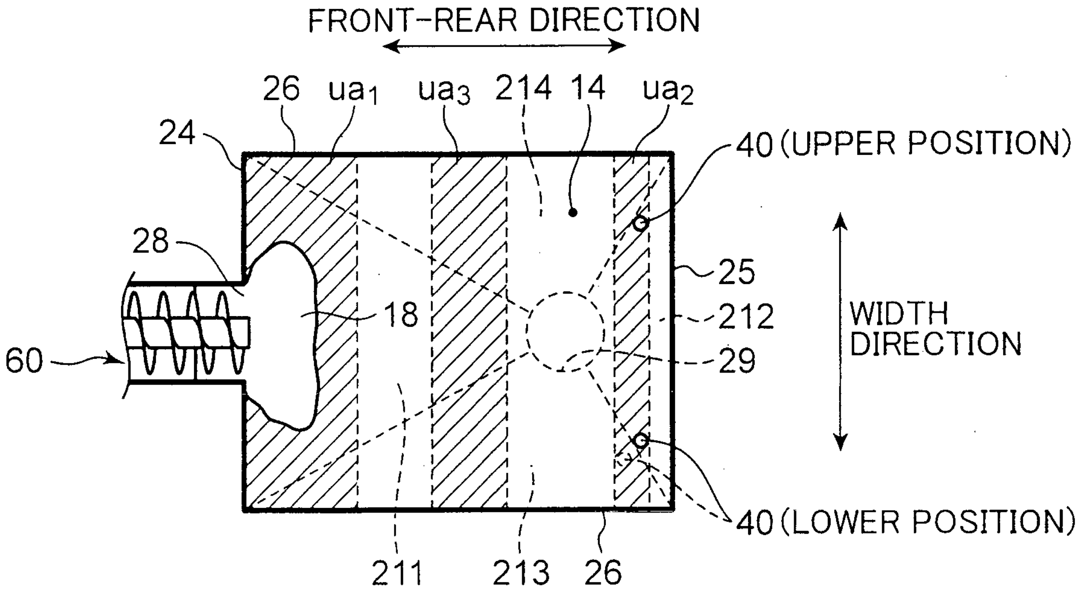

FRONT-REAR DIRECTION
26
ua1
ua3
214
14
ua2
24
40 (UPPER POSITION)
28
25
18
212
WIDTH DIRECTION
60
29
40 (LOWER POSITION)
211
213
26

FIG.3

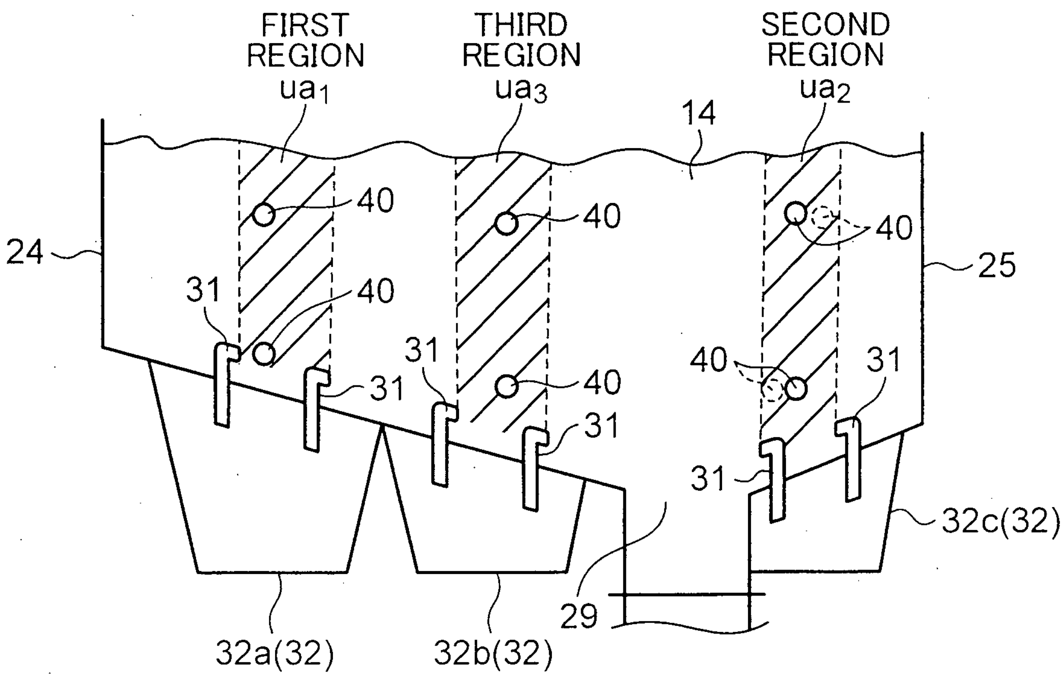

FIRST REGION ua1
THIRD REGION ua3
SECOND REGION ua2
14
40
24
25
31
32c(32)
29
32a(32)
32b(32)

FIG.4

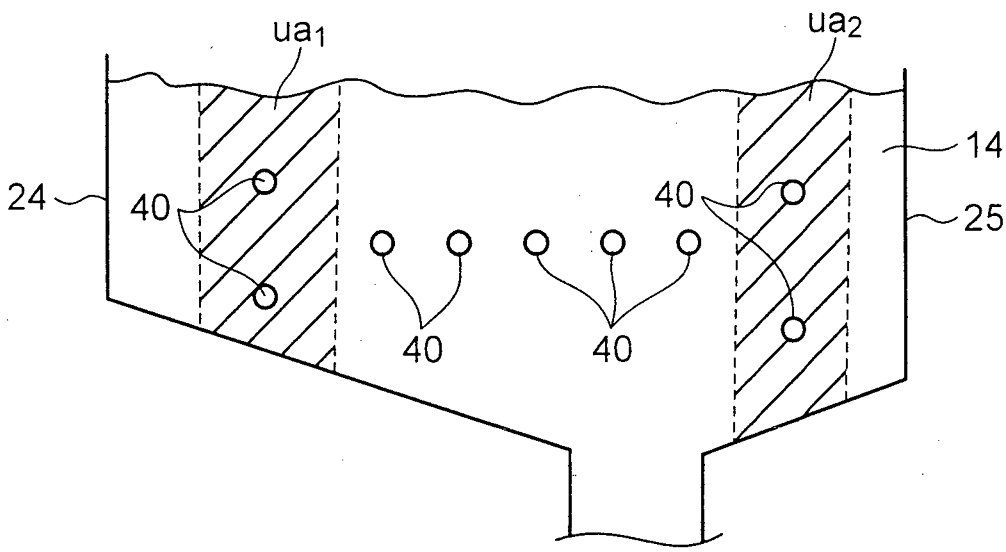
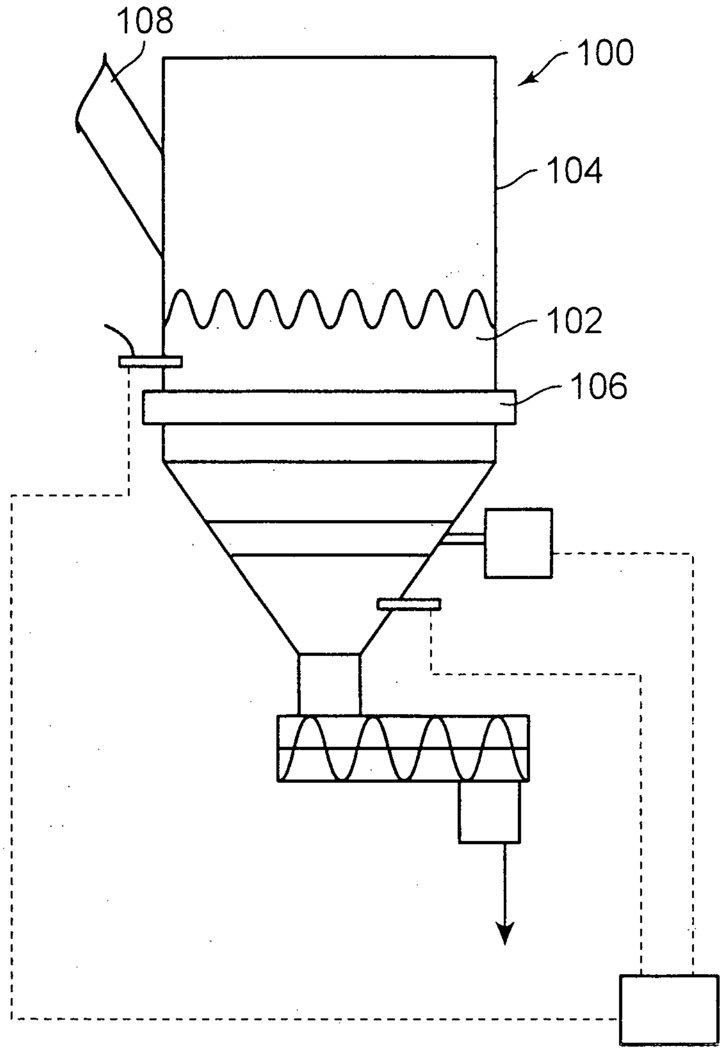


FIG.5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/001741

A. CLASSIFICATION OF SUBJECT MATTER
F23G5/027(2006.01)i, *B09B3/00*(2006.01)i, *C10J3/00*(2006.01)i, *F23C10/28*(2006.01)i, *F23G5/30*(2006.01)i, *F23G5/50*(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)
F23G5/027, B09B3/00, C10J3/00, F23C10/28, F23G5/30, F23G5/50

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	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

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.
A	JP 2007-271203 A (Mitsubishi Heavy Industries, Ltd.), 18 October 2007 (18.10.2007), entire text; all drawings (Family: none)	1-4
A	JP 05-180427 A (Ishikawajima-Harima Heavy Industries Co., Ltd.), 23 July 1993 (23.07.1993), entire text; all drawings (Family: none)	1-4
A	JP 07-243632 A (Kawasaki Heavy Industries, Ltd.), 19 September 1995 (19.09.1995), entire text; all drawings (Family: none)	1-4

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

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"&" document member of the same patent family

Date of the actual completion of the international search 23 April, 2012 (23.04.12)	Date of mailing of the international search report 01 May, 2012 (01.05.12)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/001741

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2007-113880 A (Kobe Steel, Ltd.), 10 May 2007 (10.05.2007), entire text; all drawings (Family: none)	1-4
A	JP 04-347407 A (Hitachi Zosen Corp.), 02 December 1992 (02.12.1992), entire text; all drawings (Family: none)	1-4

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2006242454 A **[0007]**