

DESCRIPTION

CONTROL SYSTEM AND OPERATION PLANNING METHOD

5 Technical Field

[0001]

The present disclosure relates to a control system and an operation planning method.

Priority is claimed on Japanese Patent Application No. 2022-096009, filed June 14, 2022, the content of which is incorporated herein by reference.

10 Background Art

[0002]

Patent Literature 1 discloses a crane control device that divides and manages a waste storing section into a plurality of areas (mixing area, acceptance area, non-mixing area, and the like). The crane control device disposes one mixing area over most of the waste storing section in a longitudinal direction (a direction perpendicular to a direction from the waste storing section toward a hopper) or disposes a plurality of mixing areas among which restacking is performed, in parallel in the longitudinal direction, and is used in an incineration plant where only one crane is provided. The crane control device grabs waste from an area set as a mixing area and inputs waste into the hopper.

20 [0003]

Patent Literature 2 discloses a crane control system including a camera that images a waste pit to generate an image, a map creation unit that creates a waste type map representing a waste type of each unit section based on the image captured by the camera, a mixing degree evaluation unit that performs scanning with a filter corresponding to a size of a bucket in the waste type map to evaluate a degree of mixing of waste at each position, and a destination

determination unit that determines a destination of the bucket based on the degree of mixing of waste at each position. In the crane control system, the waste type map is created in the entire region of the image captured by the camera or the entire region excluding a wall area of the waste pit, and is used in destination determination of a restacking operation or the like.

5 Citation List

Patent Literature

[0004]

Patent Literature 1: Japanese Unexamined Patent Application, First Publication No. 2017-218316

10 Patent Literature 2: Japanese Unexamined Patent Application, First Publication No. 2022-029405

Summary of Invention

Technical Problem

[0005]

15 Incidentally, in a case of performing crane operation automation in a waste pit where a plurality of cranes are operated, control contents need to be managed such that a plurality of cranes do not interfere with each other and designed individually for each incineration plant according to one or more of a waste acceptance processing amount of the incineration plant, a furnace processing capacity, furnace disposition, the number of furnaces, a scale of a waste
20 pit, the number of cranes, an operation policy of the incineration plant, and the like, and it is difficult to perform operation automation.

[0006]

The present disclosure has been accomplished to solve the above-described problem, and an object of the present disclosure is to provide a control system and an operation
25 planning method capable of easily performing operation automation of a plurality of cranes.

Solution to Problem

[0007]

To solve the above-described problem, there is provided a control system of the present disclosure including an area function setting unit configured to set an area usage method at a predetermined time for each of a plurality of areas in a pit where materials to be incinerated are deposited, an operation setting unit configured to set an operation mode for each of a plurality of cranes, and a control unit configured to control each of the plurality of cranes based on a combination of the area usage method set by the area function setting unit and the operation mode set by the operation setting unit. The plurality of areas include at least a first area and a second area. The area function setting unit is configured to prevent an input of the materials to be incinerated in a hopper of an incinerator to set an acceptance destination area where the materials to be incinerated are accepted, to the first area and set an input area where the materials to be incinerated are input into the hopper, to the second area as the area usage method at a first time, and set the input area to the first area and set the acceptance destination area to the second area as the area usage method at a second time different from the first time.

[0008]

To solve the above-described aspect, there is provided an operation planning method of the present disclosure for a plurality of cranes that are operated in a storing section of materials to be incinerated, the operation planning method comprising, by a computer, registering a plurality of area usage methods to be set for a plurality of areas in a pit of the storing section, registering a plurality of operation modes to be set for the plurality of cranes, and selectively combining the plurality of area usage methods and the plurality of operation modes according to facility contents or an operation policy of the storing section to derive an operation plan of the plurality of cranes. The plurality of areas include at least a first area

and a second area. The plurality of area usage methods include preventing an input of the materials to be incinerated in a hopper of an incinerator to set an acceptance destination area where the materials to be incinerated are accepted, to the first area and setting an input area where the materials to be incinerated are input into the hopper, to the second area as the area
5 usage method at a first time, and setting the input area to the first area and setting the acceptance destination area to the second area as the area usage method at a second time different from the first time.

Advantageous Effects of Invention

[0009]

10 With the control system and the operation planning method of the present disclosure, it is possible to easily perform operation automation of a plurality of cranes.

Brief Description of Drawings

[0010]

[FIG. 1] A schematic configuration diagram illustrating an incineration plant
15 according to an embodiment of the present disclosure.

[FIG. 2] A cross-sectional view illustrating a combustion plant according to the embodiment of the present disclosure as viewed from above.

[FIG. 3] A block diagram illustrating a functional configuration related to a control device according to the embodiment of the present disclosure.

20 [FIG. 4] A diagram illustrating a function of an area function setting unit according to the embodiment of the present disclosure.

[FIG. 5] A diagram illustrating the function of the area function setting unit according to the embodiment of the present disclosure.

[FIG. 6] A diagram illustrating a function of an operation setting unit according to
25 the embodiment of the present disclosure.

[FIG. 7] A flowchart illustrating vertical mixing according to the embodiment of the present disclosure.

[FIG. 8] A flowchart illustrating moving mixing according to the embodiment of the present disclosure.

5 [FIG. 9] A flowchart illustrating moving and scattering mixing according to the embodiment of the present disclosure.

[FIG. 10] A flowchart illustrating an input operation according to the embodiment of the present disclosure.

[FIG. 11] A block diagram illustrating a functional configuration of a control unit
10 according to the embodiment of the present disclosure.

[FIG. 12] A flowchart illustrating a flow of an operation planning method according to the embodiment of the present disclosure.

[FIG. 13] A flowchart illustrating a flow of control of a crane according to the embodiment of the present disclosure.

15 [FIG. 14] A flowchart illustrating a flow of control of a crane according to the embodiment of the present disclosure.

[FIG. 15] A flowchart illustrating a flow of control of a crane according to the embodiment of the present disclosure.

[FIG. 16] A flowchart illustrating a flow of control of a crane according to the
20 embodiment of the present disclosure.

[FIG. 17] A hardware configuration diagram illustrating a configuration of a computer according to the embodiment of the present disclosure.

Description of Embodiments

[0011]

25 Hereinafter, a control system and an operation planning method according to an

embodiment of the present disclosure will be described with reference to the drawings. In the following description, configurations having the same or similar functions are represented by the same reference signs. Then, duplicate description of such configurations may not be repeated. In the present disclosure, a phrase "based on XX" means "based on at least XX" and may also include a case based on another element in addition to XX. The phrase "based on XX" is not limited to a case where XX is directly used and may also include a case where arithmetic operation or processing is performed on XX. In the present disclosure, a phrase "XX or YY" is not limited to a case of any one of XX and YY and may also include a case of both XX and YY. The same applies to a case where there are three or more selective elements. "XX" and "YY" are arbitrary elements (for example, arbitrary information). In the present disclosure, the term "acquisition" is not limited to a case where a transmission request is transmitted to actively acquire information and may also include a case where information is acquired by passively receiving information transmitted from another device. In the present disclosure, a database is written as a "DB".

15 [0012]

Here, first, a +X direction, a -X direction, a +Y direction, a -Y direction, and a Z direction are defined. The +X direction, the -X direction, the +Y direction, and the -Y direction are directions along a horizontal plane. The +X direction is a direction from a waste pit 21 described below toward a hopper 11 (see FIG. 1). The -X direction is an opposite direction to the +X direction. The +X direction and the -X direction are simply referred to as an "X direction" in a case where there is no need for distinction therebetween. The +Y direction and the -Y direction are directions intersecting (for example, perpendicular to) the X direction. The +Y direction is a direction from a first hopper 11A described below toward a second hopper 11B (see FIG. 2). The -Y direction is an opposite direction to the +Y direction. The +Y direction and the -Y direction are simply referred to as a "Y

direction" in a case where there is no need for distinction therebetween. The Z direction is a direction intersecting (for example, perpendicular to) the X direction and the Y direction.

The Z direction is, for example, a vertical direction (see FIG. 1).

[0013]

5 (Embodiment)

<1. Overall Configuration of Incineration Plant>

FIG. 1 is a schematic configuration diagram illustrating an incineration plant 1 according to an embodiment. The incineration plant 1 is, for example, a stoker furnace that has municipal waste, industrial waste, biological mass, and the like as materials G to be
10 incinerated. The incineration plant 1 is not limited to a stoker furnace, and may be another type of incineration plant. Hereinafter, for convenience of description, "materials to be incinerated" may be referred to as "waste". The incineration plant 1 includes, for example, a storing section 2 and an incinerator 3.

[0014]

15 (Storing Section)

The storing section 2 is equipment that stores collected materials G to be incinerated and inputs the stored materials G to be incinerated into the incinerator 3. The storing section 2 will be described below in detail.

[0015]

20 (Incinerator)

The incinerator 3 is a furnace that combusts the materials G to be incinerated while transporting the materials G to be incinerated. The incinerator 3 includes, for example, a hopper 11 and a furnace main body 12.

[0016]

25 The hopper 11 is a temporary storing section that is provided to supply the materials

G to be incinerated to the inside of the furnace main body 12. The hopper 11 opens upward. The materials G to be incinerated are input into the hopper 11 by a crane 30 of the storing section 2 described below. The hopper 11 is provided with a feeder (not illustrated). The feeder moves the materials G to be incinerated stored in the hopper 11 toward the inside of the furnace main body 12.

[0017]

The hopper 11 has a level meter 11s (see FIG. 3). The level meter 11s is a sensor that detects an amount of the materials G to be incinerated stored in the hopper 11. The level meter 11s transmits a signal (hereinafter, referred to as "input request signal") for requesting to input materials G to be incinerated into the hopper 11 to a control device 100 of the storing section 2 described below in a case where a top surface of the materials G to be incinerated stored in the hopper 11 is lower than a predetermined position.

[0018]

The furnace main body 12 is equipment that combusts the materials G to be incinerated while transporting the materials G to be incinerated. The furnace main body 12 is provided adjacent to the hopper 11. The furnace main body 12 includes a processing space V where the materials G to be incinerated are combusted.

[0019]

FIG. 2 is a cross-sectional view illustrating the incineration plant 1 as viewed from above. In the present embodiment, the incinerator 3 includes a plurality of hoppers 11 and furnace main bodies 12. For example, the incinerator 3 has, as a plurality of furnace main bodies 12, a first furnace main body 12A disposed on a -Y direction side and a second furnace main body 12B disposed on a +Y direction side. Similarly, the incinerator 3 has, as a plurality of hoppers 11, a first hopper 11A disposed on the -Y direction side and connected to the first furnace main body 12A and a second hopper 11B disposed on the +Y direction

side and connected to the second furnace main body 12B. The first hopper 11A and the second hopper 11B are disposed in parallel in the Y direction. In the present embodiment, the first hopper 11A and the second hopper 11B are simply referred to as a "hopper 11" in a case where there is no need for distinction therebetween. Each of the number of hoppers 11 and the number of furnace main bodies 12 provided in the incinerator 3 is not limited to two, and may be one or may be three or more.

[0020]

<2. Configuration of Storing Section>

Next, the storing section 2 will be described.

As illustrated in FIG. 2, the storing section 2 includes, for example, a waste pit 21, a platform 22, a plurality of waste acceptance gates 23, a plurality of cranes 30, and a waste height detection device 41 (see FIG. 1).

[0021]

(Waste Pit)

The waste pit 21 is an accommodation section that is provided in a previous stage of the incinerator 3 and stores the materials G to be incinerated before input into the incinerator 3. As viewed from above, the waste pit 21 has a rectangular shape having long sides along the Y direction and short sides along the X direction. The waste pit 21 has an opening for accepting the materials G to be incinerated in an upper portion of the waste pit 21 (see FIG. 1).

[0022]

(Platform)

The platform 22 is an import section where a work vehicle P (hereinafter, referred to as "garbage truck P") that collects the materials G to be incinerated outside arrives. The platform 22 is provided adjacent to one end of the waste pit 21 on the -X direction side.

[0023]

(Waste Acceptance Gate)

The plurality of waste acceptance gates 23 are provided between the waste pit 21 and the platform 22. The plurality of waste acceptance gates 23 are disposed in parallel in the Y direction and can be opened and closed independently of each other. In a case where the garbage truck P arrives at the platform 22, the waste acceptance gate 23 corresponding to a position of the arrived garbage truck P among the plurality of waste acceptance gates 23 is opened.

[0024]

Each waste acceptance gate 23 has an opening/closing sensor 23s (see FIG. 3). The opening/closing sensor 23s is a sensor that detects that the waste acceptance gate 23 in which the opening/closing sensor 23s is provided is opened. In a case where the waste acceptance gate 23 in which the opening/closing sensor 23s is provided is opened, the opening/closing sensor 23s transmits a signal (hereinafter, referred to as "acceptance gate open signal") indicating that the waste acceptance gate 23 is opened, to the control device 100 of the storing section 2.

[0025]

(Crane)

As illustrated in FIG. 1, the crane 30 grips a part of the materials G to be incinerated stored in the waste pit 21, carries the gripped materials G to be incinerated to the hopper 11 of the incinerator 3, and inputs the materials G to be incinerated into the hopper 11. The crane 30 is provided above the waste pit 21. The crane 30 has, for example, a moving mechanism 31, a wire 32, a traction machine 33, and a grapple 34.

[0026]

The moving mechanism 31 has, for example, a pair of rails 31a, a girder 31b, and a

trolley 31c. The pair of rails 31a are provided in an upper portion of the storing section 2. The pair of rails 31a is disposed separately on both sides of the waste pit 21 in the X direction and extends in the Y direction. The girder 31b is disposed to straddle on the pair of rails 31a and can be moved in the Y direction along the rails 31a. The trolley 31c is disposed on the girder 31b and can be moved in the X direction along the girder 31b.

[0027]

The wire 32 is suspended from the trolley 31c. The traction machine 33 is provided in the trolley 31c and winds and unwinds the wire 32. The grapple 34 is attached to a tip of the wire 32. The grapple 34 has a plurality of claws 34a for gripping the materials G to be incinerated. The grapple 34 is an example of a "grip portion" for that grips the materials G to be incinerated. The grapple 34 can be moved to an arbitrary position in the X direction, the Y direction, and the Z direction by the moving mechanism 31 and the traction machine 33.

[0028]

As illustrated in FIG. 2, the storing section 2 of the present embodiment has, as the plurality of cranes 30, a first crane 30A disposed on the -Y direction side and a second crane 30B disposed on the +Y direction side. The first crane 30A and the second crane 30B are disposed in parallel in the Y direction. The first crane 30A and the second crane 30B share the pair of rails 31a. For this reason, the first crane 30A cannot be moved to the +Y direction side beyond the second crane 30B. The second crane 30B cannot be moved to the -Y direction side beyond the first crane 30A. In the present embodiment, the first crane 30A and the second crane 30B are referred to as a "crane 30" in a case where there is no need for distinction therebetween. The plurality of cranes 30 that are provided in the storing section 2 are not limited to two cranes 30 and may be three or more cranes 30.

[0029]

Each crane 30 has a position sensor 35 and a weight sensor 36 (see FIG. 3). The position sensor 35 detects a position in the X direction and the Y direction of the crane 30 in which the position sensor 35 is provided. Information (hereinafter, referred to as "position information") indicating the position of the crane 30 detected by the position sensor 35 is transmitted to the control device 100 of the storing section 2. In the present disclosure, "the position of the crane" means a position of the grapple 34. On the other hand, the weight sensor 36 detects a weight of the materials G to be incinerated gripped by the grapple 34 of the crane 30 in which the weight sensor 36 is provided. Information (hereinafter, referred to as "weight information") indicating the weight of the materials G to be incinerated detected by the weight sensor 36 is transmitted to the control device 100 of the storing section 2.

[0030]

(Waste Height Detection Device)

As illustrated in FIG. 1, the waste height detection device 41 detects a height of a top surface of the materials G to be incinerated stored in the waste pit 21. The waste height detection device 41 is, for example, a laser scanner and irradiates and scans the surface of the materials G to be incinerated stored in the waste pit 21 with laser light, measures a time (time of flight (TOF)) from irradiation of laser light until reception of laser light reflected by the surface of the materials G to be incinerated, and transmits measured information as a detection result of the waste height detection device 41 to the control device 100 of the storing section 2. The waste height detection device 41 detects the height of the top surface of the materials G to be incinerated in a predetermined period (for example, every hour).

[0031]

The waste height detection device 41 may be a device that measures a distance based on parallax of a stereo image, a device that captures an image obtained by projecting an image of a predetermined pattern and measures a distance based on deviation of the imaged

pattern, or a device that detects the height of the top surface of the materials G to be incinerated through irradiation of infrared rays, sound waves, or radio waves, instead of the above-described example. The waste height detection device 41 is an example of a "sensor".

5 [0032]

Next, other configurations included in the storing section 2 will be described.

FIG. 3 is a block diagram illustrating a functional configuration related to the control device 100. The storing section 2 includes, for example, an input device 51, a display device 52, an operation panel 53, and the control device 100, in addition to the above-

10 described configurations.

[0033]

(Input Device)

The input device 51 is a device that has a keyboard, a touch panel, and the like, and can receive an input by an operator. For example, the equipment content (one or more of

15 the waste acceptance processing amount of the incineration plant 1, the furnace processing capacity, furnace disposition, the number of furnaces, the scale of the waste pit, the number of cranes, and the like) of the combustion plant 1 or the operation policy of the incineration plant 1 is changed, the input device 51 receives an input of information regarding the equipment content or the operation policy after change. "Information regarding the

20 equipment content or the operation policy after change" includes, for example, information indicating an index value or a threshold for determination (for selection) set according to the equipment content or the operation policy after change. Such information will be described below. Information received by the input device 51 is transmitted as information for setting to the control device 100.

25 [0034]

(Display Device)

The display device 52 has a display screen that can display various kinds of information, and displays display information received from the control device 100. For example, an operation plan of the plurality of cranes 30 generated by the control device 100 is displayed on the display device 52. In a case where an alarm is generated by the control device 100, the content of the generated alarm is displayed on the display device 52.

[0035]

(Operation Panel)

The operation panel 53 is a device that receives an operation of the operator regarding the crane 30. For example, in a case where an alarm is generated by the control device 100, the operator switches the crane 30 in an automatic operation to manual operation by operating the operation panel 53. Information received by the operation panel 53 is transmitted as an operation signal to the control device 100.

[0036]

<3. Configuration of Control Device>

Next, the control device 100 will be described.

The control device 100 is a control device that performs automatic operation of the plurality of cranes 30 to be operated in the waste pit 21. The control device 100 is an example of a "control system". Some or all of functional units included in the control device 100 may be provided as a part of a control device that controls the entire incineration plant 1, instead of the control device 100 of the storing section 2.

[0037]

The control device 100 of the present embodiment has, for example, an information acquisition unit 110, an area function setting unit 120, an operation setting unit 130, a control unit 140, a setting reception unit 150, and a storage unit 160.

[0038]

<3.1 Information Acquisition Unit>

The information acquisition unit 110 acquires various kinds of information necessary for the control device 100. For example, the information acquisition unit 110 acquires the input request signal transmitted from the hopper 11, the acceptance gate open signal transmitted from the waste acceptance gate 23, the position information transmitted from the position sensor 35 of the crane 30, the weight information transmitted from the weight sensor 36 of the crane 30, and the detection result transmitted from the waste height detection device 41.

[0039]

<3.2 Area Function Setting Unit>

The area function setting unit 120 sets an area usage method at each predetermined time for each of a plurality of areas in the waste pit 21. The area usage method is not created, for example, for a specific incineration plant, and is an operation pattern of each area patterned (generalized) in advance to be set for an arbitrary incineration plant.

[0040]

FIGS. 4 and 5 are diagrams illustrating a function of the area function setting unit 120. In the present embodiment, the area function setting unit 120 sets a plurality of virtual sections R in the waste pit 21. The plurality of sections R are disposed, for example, in a lattice. FIGS. 4 and 5 illustrate, for convenience of description, an example where 60 sections R in total of six rows in the X direction and ten columns in the Y direction are set in the waste pit 21. Note that the number of sections R is not limited to the above-described example, and may be smaller than the above-described example or may be greater than the above-described example. For example, the sections R are set to be small to such an extent that two or more sections R arranged in the Y direction correspond to one waste acceptance

gate 23. Each section R is not limited to a square shape and may have a rectangular shape. The sections R in the entire area of the waste pit 21 do not necessarily have the same size, and there may be sections R having different sizes.

[0041]

5 In the present embodiment, the area function setting unit 120 sets, as the plurality of areas in the waste pit 21, first to third areas A1 to A3. The first area A1 includes, for example, 20 sections R specified by four rows on the +X direction side and five columns on the -Y direction side among the plurality of sections R described above. The second area A2 includes, for example, 20 sections R specified by four rows on the +X direction side and
10 five columns on the +Y direction side among the plurality of sections R described above. The third area A3 includes nine sections R included in one row on the most -X direction side among the plurality of sections R. In the third area A3, a first dedicated area C1 and a second dedicated area C2 may be further set. The first dedicated area C1 includes one or more sections R on the most -Y direction side in the third area A3. The second dedicated
15 area C2 includes one or more sections R on the most +Y direction side in the third area A3.

[0042]

The first to third areas A1 to A3 may be virtual areas or may be areas actually divided by banks or the like. The setting of the first to third areas A1 to A3 is not limited to the above-described example. For example, the first area A1 and the second area A2 may
20 be different in size. The setting of the first dedicated area C1 and the second dedicated area C2 may be omitted.

[0043]

In the present embodiment, the area function setting unit 120 sets an area usage method at a predetermined time for each of the first to third areas A1 to A3. In the present
25 embodiment, an "acceptance source area", an "acceptance destination area", an "input area", a

"first crane dedicated acceptance source area", and a "second crane dedicated acceptance source area" are patterned in advance and prepared as an area usage method, and are registered in an area function DB 161 of the storage unit 160.

[0044]

5 The "acceptance source area" is an area where the materials G to be incinerated are accepted from the garbage truck P. The "acceptance source area" is an area where the materials G to be incinerated can be gripped by any of the first crane 30A and the second crane 30B.

[0045]

10 The "acceptance destination area" is an area where the materials G to be incinerated moved from the "acceptance source area" are accepted (set an arrow in FIG. 4). The "acceptance destination area" is an area where an input of the materials G to be incinerated in the acceptance destination area into the hopper 11 is prevented. In the "acceptance destination area", the materials G to be incinerated are restacked in the acceptance destination
15 area, and the properties of the materials G to be incinerated are leveled. In the present embodiment, the materials G to be incinerated are also accepted in the "acceptance destination area" from a "first crane dedicated acceptance source area" and a "second crane dedicated acceptance source area" described below.

[0046]

20 The "input area" is an area where the materials G to be incinerated in the input area are input into the hopper 11 (see an arrow in FIG. 5) in a case where a request (for example, the input request signal from the hopper 11) from the incinerator 3 is received. Since the above-described input work is intermittent, in the "input area", the materials G to be incinerated are restacked in the input area in an interval of the input work and the properties
25 of the materials G to be incinerated are leveled.

[0047]

The "first crane dedicated acceptance source area" and the "second crane dedicated acceptance source area" are areas where the materials G to be incinerated are accepted from the garbage truck P, similarly to other sections R in the "acceptance source area". The "first crane dedicated acceptance source area" is an area where only the first crane 30A can grip the materials G to be incinerated, for example, since the first crane 30A and the second crane 30B interfere with each other. The "first crane dedicated acceptance source area" may be set as an acceptance source area simply allocated to the first crane 30A without reference to the interference between the first crane 30A and the second crane 30B. The "second crane dedicated acceptance source area" is an area where only the second crane 30B can grip the materials G to be incinerated, for example, since the first crane 30A and the second crane 30B interfere with each other. The "second crane dedicated acceptance source area" may be set as an acceptance source area simply allocated to the second crane 30B without reference to the interference between the first crane 30A and the second crane 30B.

[0048]

In the present embodiment, the area function setting unit 120 sets the "acceptance source area", the "acceptance destination area", the "input area", the "first crane dedicated acceptance source area", and the "second crane dedicated acceptance source area" as an area usage method at a predetermined time for a plurality of areas in the waste pit 21. For example, the area function setting unit 120 sets the "acceptance destination area" for the first area A1, sets the "input area" for the second area A2, sets the "acceptance source area" for the third area A3, sets the "first crane dedicated acceptance source area" for the first dedicated area C1, and sets the "second crane dedicated acceptance source area" for the second dedicated area C2, as an area usage method at a first time (for example, 24 hours of a certain day).

[0049]

On the other hand, the area function setting unit 120 sets the "input area" for the first area A1, sets the "acceptance destination area" for the second area A2, sets the "acceptance source area" for the third area A3, sets the "first crane dedicated acceptance source area" for the first dedicated area C1, and sets the "second crane dedicated acceptance source area" for the second dedicated area C2, as an area usage method at a second time (for example, 24 hours of a next day) different from the first time. That is, in the present embodiment, in regard to the first area A1 and the second area A2, the materials G to be incinerated stored in each area is kept unchanged, and a function to be allocated is alternately replaced at each predetermined time (for example, every day).

[0050]

In the present embodiment, as the "input area", for example, only one area among a plurality of areas in the waste pit 21 is set. That is, at the above-described first time, in both a case where the input request signal is received from the first hopper 11A and a case where the input request signal is received from the second hopper 11B, the materials G to be incinerated are input into the first hopper 11A or the second hopper 11B from the second area A2. On the other hand, at the above-described second time, in both a case where the input request signal is received from the first hopper 11A and a case where the input request signal is received from the second hopper 11B, the materials G to be incinerated are input into the first hopper 11A or the second hopper 11B from the first area A1.

[0051]

<3.3 Operation Setting Unit>

Next, the operation setting unit 130 will be described. The operation setting unit 130 sets an operation mode at each predetermined time for each of the plurality of cranes 30. The operation mode is not created for a specific incineration plant and is an operation pattern

of each crane 30 patterned (generalized) in advance to be set for an arbitrary incineration plant.

[0052]

FIG. 6 is a diagram illustrating a function of the operation setting unit 130. In the present embodiment, the operation setting unit 130 sets an operation mode at a predetermined time for each of the first crane 30A and the second crane 30B. In the present embodiment, an "input mode" and an "acceptance mode" are patterned in advance and prepared as the operation mode, and are registered in an operation mode DB 162 of the storage unit 160.

[0053]

The "input mode" is an operation mode where the materials G to be incinerated in the input area are input into the hopper 11 in a case where the request (for example, the input request signal from the hopper 11) from the incinerator 3 is received. Since the above-described input work is intermittent, in the "input mode", the materials G to be incinerated are restacked in the input area in the interval of the input work, and the properties of the materials G to be incinerated are leveled. In the present embodiment, in the "input mode", the materials G to be incinerated are moved from the acceptance source area to the acceptance destination area in the interval of the input work. For example, in the "input mode", the materials G to be incinerated are moved from the acceptance source area ("first crane dedicated acceptance source area" or "second crane dedicated acceptance source area") where the crane 30 set in the input mode is dedicated, to the acceptance destination area. The crane 30 set in the input mode may also move the materials G to be incinerated from a section R other than a section R where the crane 30 is dedicated ("first crane dedicated acceptance source area" or "second crane dedicated acceptance source area"), in the acceptance source area to the acceptance destination area.

[0054]

In the present embodiment, a plurality of work contents each patterned (generalized) as unit work are associated with the "input mode". The plurality of work contents include, for example, "acceptance work", "restacking work", and "input work". The "acceptance work" is work that the crane 30 set in the input mode moves the materials G to be incinerated from the acceptance source area (for example, the dedicated acceptance source area where the crane 30 set in the input mode is dedicated) to the acceptance destination area. The "restacking work" is work of restacking the materials G to be incinerated in the input area. The "input work" is work of inputting the materials G to be incinerated in the input area into the hopper 11. The work contents as such unit work are registered in the operation mode DB 162 of the storage unit 160.

[0055]

On the other hand, the "acceptance mode" is an operation mode where the input of the materials G to be incinerated into the hopper 11 is prevented and the materials G to be incinerated are accepted from the acceptance source area in the acceptance destination area. In the "acceptance mode", the materials G to be incinerated in the acceptance destination area are restacked in an interval of the acceptance work, and the properties of the materials G to be incinerated are leveled. In the present embodiment, in the "acceptance mode", the materials G to be incinerated are moved from the acceptance source area to the acceptance destination area. For example, in the "acceptance mode", the materials G to be incinerated are moved from a section R (hereinafter, referred to as "section R of specific area") other than the dedicated acceptance source area where the crane 30 set in the input mode is dedicated, in the acceptance source area to the acceptance destination area.

[0056]

In the present embodiment, a plurality of work contents each patterned (generalized) as a unit work are associated with the "acceptance mode". The plurality of work contents

include, for example, "acceptance work" and "restacking work". The "acceptance work" is work of moving the materials G to be incinerated from the section R of the specific area described above in the acceptance source area to the acceptance destination area. The "restacking work" is work of restacking the materials G to be incinerated in the acceptance destination area.

[0057]

In the present embodiment, a plurality of mixing methods patterned (generalized) in advance are prepared as unit work, respectively. The plurality of mixing methods include, for example, "vertical mixing", "moving mixing", and "moving and scattering mixing". An input operation patterned in advance is prepared as unit work in the same column as the mixing method. The mixing method and the input operation as such unit work are registered in the operation mode DB 162 of the storage unit 160.

[0058]

FIG. 7 is a flowchart illustrating the "vertical mixing". The "vertical mixing" as unit work includes a sequence of work including moving the crane 30 to a gripping position of the materials G to be incinerated (S11), gripping and lifting the materials G to be incinerated by the crane 30 (S12), and releasing the gripping of the materials G to be incinerated at the lifted position to execute the vertical mixing (S13).

[0059]

FIG. 8 is a flowchart illustrating the "moving mixing". The "moving mixing" as unit work includes a sequence of work including moving the crane 30 to a gripping position of the materials G to be incinerated (S21), gripping and lifting the materials G to be incinerated by the crane 30 (S22), moving the crane 30 from a position where the materials G to be incinerated are lifted, in at least one of the X direction and the Y direction (S23), and thereafter, releasing the gripping of the materials G to be incinerated to execute the moving

mixing (S24).

[0060]

FIG. 9 is a flowchart illustrating the "moving and scattering mixing". The "moving and scattering mixing" as unit work includes a sequence of work including moving the crane 30 to a gripping position of the materials G to be incinerated (S31), gripping and lifting the materials G to be incinerated by the crane 30 (S32), moving the crane 30 from a position where the materials G to be incinerated are lifted, to a start position of the moving and scattering mixing in at least one of the X direction and the Y direction (S33), and thereafter, gradually releasing the gripping of the materials G to be incinerated while moving the crane 30 to execute the moving and scattering mixing (S34).

[0061]

FIG. 10 is a flowchart illustrating the "input operation". The "input operation" as unit work includes a sequence of work including gripping and lifting the materials G to be incinerated by the crane 30 (S41), moving the crane 30 from a position where the materials G to be incinerated are lifted, to the hopper 11 (S42), and thereafter, inputting the materials G to be incinerated into the hopper 11 by releasing the gripping of the materials G to be incinerated (S43).

[0062]

In the present embodiment, as the mixing method of the materials G to be incinerated, one or more (for example, two or more) of the vertical mixing, the moving mixing, and the moving and scattering mixing patterned as unit work are associated as candidates with each of the acceptance work and the restacking work associated with the acceptance mode and each of the acceptance work and the restacking work associated with the input mode, and can be arbitrarily selected.

[0063]

For example, as illustrated in FIG. 6, the "moving and scattering mixing" and the "moving mixing" are associated as candidates with the "acceptance work" of the "input mode", and can be arbitrarily selected. The "moving and scattering mixing" and the "moving mixing" are associated as candidates with the "restacking work" of the "input mode", and can be arbitrarily selected. The "vertical mixing" is associated as a candidate with the "input work" of the "input mode", and can be arbitrarily selected. On the other hand, the "moving and scattering mixing" and the "moving mixing" are associated as candidates with the "acceptance work" of the "acceptance mode", and can be arbitrarily selected. The "vertical mixing" and the "moving mixing" are associated as candidates with the "restacking work" of the "acceptance mode", and can be arbitrarily selected.

[0064]

In the present embodiment, the control unit 140 described below executes, as the mixing method of the materials G to be incinerated, one or more arbitrary mixing methods among one or more mixing methods associated as candidates based on the setting received by the setting reception unit 150 described below or a detection result of one or more sensors (for example, based on one or more of a waste mound height described below, a waste property (degree of progress of mixing or the like), and an opening/closing status of the waste acceptance gate 23) in association with each of a plurality of types of work (for example, the acceptance work and the restacking work) associated with the acceptance mode and each of a plurality of types of works (for example, the acceptance work and the restacking work) associated with the input mode.

[0065]

For example, the control unit 140 associates the "vertical mixing" with the "input work", associates the "moving mixing" with the "acceptance work", and associates the "moving mixing" with the "restacking work" based on the setting received by the setting

reception unit 150 or the detection result of one or more sensors. The control unit 140 may execute two or more arbitrary mixing methods among a plurality of mixing methods associated as candidates in association with each type of work. For example, the control unit 140 may execute the "moving mixing" and the "vertical mixing" in association with the "restacking work", and may execute two times or more of the "moving mixing" in association with the "restacking work", based on the setting received by the setting reception unit 150 or the detection result of one or more sensors.

[0066]

In the present embodiment, the operation setting unit 130 sets the "input mode" or the "acceptance mode" as the operation mode at a predetermined time for the plurality of cranes 30. For example, the operation setting unit 130 sets the "acceptance mode" for the first crane 30A, and sets the "input mode" for the second crane 30B, as the operation mode at the above-described first time. On the other hand, the operation setting unit 130 sets the "input mode" for the first crane 30A, and sets the "acceptance mode" for the second crane 30B, as the operation mode at the above-described second time. That is, in the present embodiment, in regard to the first crane 30A and the second crane 30B, the operation mode to be allocated is alternately replaced at each predetermined time (for example, every day).

[0067]

In the present embodiment, as the "input crane", only one crane 30 among the plurality of cranes 30 is set. That is, at the above-described first time, in both a case where the input request signal is received from the first hopper 11A and a case where the input request signal is received from the second hopper 11B, the materials G to be incinerated are input into the first hopper 11A or the second hopper 11B from the input area by the second crane 30B. On the other hand, at the above-described second time, in both a case where the input request signal is received from the first hopper 11A and a case where the input request

signal is received from the second hopper 11B, the materials G to be incinerated are input into the first hopper 11A or the second hopper 11B from the input area by the first crane 30A.

[0068]

<3.4 Control Unit>

5 Next, the control unit 140 will be described. The control unit 140 controls each of the plurality of cranes 30 based on a combination of the area usage method set by the area function setting unit 120 and the operation mode set by the operation setting unit 130.

[0069]

For example, the control unit 140 grips the materials G to be incinerated deposited in
10 the acceptance source area and moves the materials G to be incinerated to the first area A1 by a combination of the "acceptance area" set for the first area A1 and the "acceptance mode" set for the first crane 30A at the above-described first time. The control unit 140 grips the materials G to be incinerated deposited in the second area A2 and inputs the materials G to be incinerated into the hopper 11 by a combination of the "input area" set for the second area A2
15 and the "input mode" set for the second crane 30B at the above-described first time. For this reason, at the above-described first time, the crane 30 that performs a main operation in the first area A1 is limited to the first crane 30A, and the crane 30 that performs a main operation in the second area A2 is limited to the second crane 30B.

[0070]

20 On the other hand, the control unit 140 grips the materials G to be incinerated deposited in the first area A1 and inputs the materials G to be incinerated into the hopper 11 by a combination of the "input area" set for the first area A1 and the "input mode" set for the first crane 30A at the above-described second time. The control unit 140 grips the materials G to be incinerated deposited in the acceptance source area and moves the materials G to be
25 incinerated to the second area A2 by a combination of the "acceptance area" set for the

second area A2 and the "acceptance mode" set for the second crane 30B at the above-described second time. For this reason, also at the above-described second time, the crane 30 that performs a main operation in the first area A1 is limited to the first crane 30A, and the crane 30 that performs a main operation in the second area A2 is limited to the second crane 30B.

[0071]

Next, the functions of the control unit 140 will be described in more detail.

FIG. 11 is a block diagram illustrating a functional configuration of the control unit 140. The control unit 140 includes, for example, a waste height calculation unit 141, a mixing frequency calculation unit 142, a bulk specific gravity calculation unit 143, an evaluation value calculation unit 144, a selection unit 145, and an operation control unit 146.

[0072]

(Waste Height Calculation Unit)

The waste height calculation unit 141 calculates a height (hereinafter, referred to as a "waste mound height") of the materials G to be incinerated deposited in the waste pit 21 based on the detection result of the waste height detection device 41. The waste mound height is calculated for each of a plurality of sections R set in the waste pit 21.

[0073]

(Mixing Frequency Calculation Unit)

The mixing frequency calculation unit 142 calculates a mixing frequency of the materials G to be incinerated based on, for example, a history of the mixing work by the crane 30. The mixing frequency of the materials G to be incinerated is calculated for each of the plurality of sections R set in the waste pit 21.

[0074]

(Bulk Specific Gravity Calculation Unit)

The bulk specific gravity calculation unit 143 calculates a bulk specific gravity of the materials G to be incinerated based on the weight information from the weight sensor 36 of the crane 30. The "bulk specific gravity" is not a specific gravity inherent to a target object and is a specific gravity calculated from a "weight per unit volume including a void".

- 5 The bulk specific gravity of the materials G to be incinerated is calculated for each of the plurality of sections R set in the waste pit 21.

[0075]

(Evaluation Value Calculation Unit)

- The evaluation value calculation unit 144 calculates an evaluation value (hereinafter, for convenience of description, referred to as an "overall evaluation value") indicating a degree of progress of mixing in each section R, for example, based on the mixing frequency in each section R calculated by the mixing frequency calculation unit 142 and the bulk specific gravity in each section R calculated by the bulk specific gravity calculation unit 143. The evaluation value calculation unit 144 may calculate the overall evaluation value in each section R based on image analysis of an image captured in the waste pit 21 instead of/in addition to the mixing frequency and the bulk specific gravity.

[0076]

(Selection Unit)

- The selection unit 145 includes a work selection unit 145a and a gripping position selection unit 145b.

[0077]

- The work selection unit 145a selects work suitable for each crane 30 from among a plurality of types of works associated with each of the acceptance mode and the input mode according to a status of the waste pit 21 or the incinerator 3, and switches work to be executed by each crane 30. For example, the work selection unit 145a switches work to be

executed among a plurality of types of works (for example, the acceptance work and the restacking work) associated with the acceptance mode based on the request from the incinerator 3 (for example, the request from the hopper 11) or the detection result of one or more sensors provided in the incineration plant 1 (for example, based on one or more of the waste mound height, the waste property (degree of progress of mixing or the like), and the opening/closing status of the waste acceptance gate 23) with respect to the crane 30 set in the acceptance mode among the plurality of cranes 30. For example, the work selection unit 145a switches work to be executed among the plurality of types of works associated with the acceptance mode based on comparison of the detection result of one or more sensors described above with a threshold Ta set in advance.

[0078]

Similarly, the work selection unit 145a switches work to be executed among a plurality of types of works (for example, the acceptance work, the restacking work, and the input work) associated with the input mode based on the request from the incinerator 3 (for example, the request from the hopper 11) or the detection result of one or more sensors provided in the incineration plant 1 (for example, based on one or more of the waste mound height, the waste property (degree of progress of mixing or the like), and the opening/closing status of the waste acceptance gate 23) with respect to the crane 30 set in the input mode among the plurality of cranes 30. For example, the work selection unit 145a switches work to be executed among the plurality of types of works associated with the input mode based on comparison of the detection result of one or more sensors described above with a threshold Tb set in advance. These contents will be described in detail in description of a control flow described below.

[0079]

In the present embodiment, the work selection unit 145a selects and executes at least

one mixing method from among one or more (for example, two or more) mixing methods associated with each of the acceptance work and the restacking work of the acceptance mode and the acceptance work and the restacking work of the input mode based on a setting content received by the setting reception unit 150 described below or the detection result of one or
 5 more sensors (for example, based on one or more of the waste mound height and the waste property (degree of progress of mixing or the like)).

[0080]

For example, the work selection unit 145a selects and executes one or more mixing methods from among two or more mixing methods based on comparison of the detection
 10 result of one or more sensors described above with a threshold T_c set in advance. For example, in a case where the degree of progress of mixing of only a specific section R is lower than a predetermined threshold, the vertical mixing for the specific section R is selected and executed. In a case where a difference in waste mound height between a certain section R and another section R is greater than a prescribed threshold, or the like, the
 15 moving mixing for moving the materials G to be incinerated from one of the two sections R to the other section is selected and executed. In a case of increasing the degree of progress of mixing of the entire area, in a case where the vertical mixing and the moving mixing are inappropriate, or the like, the moving and scattering mixing is selected and executed.

[0081]

20 The gripping position selection unit 145b selects a position of gripping the materials G to be incinerated based on the detection result of one or more sensors described above (for example, based on one or more of the waste mound height, the waste property (degree of progress of mixing or the like), and the opening/closing status of the waste acceptance gate
 23) in a case of moving the materials G to be incinerated in the acceptance work, the
 25 restacking work, or the input work. For example, the gripping position selection unit 145b

selects a position of gripping the materials G to be incinerated in the acceptance source area in a case of moving the materials G to be incinerated from the acceptance source area to the acceptance destination area. The gripping position selection unit 145b determines a position of gripping the materials G to be incinerated in the acceptance destination area or the input
 5 area in a case of restacking the materials G to be incinerated in the acceptance destination area or the input area. The gripping position selection unit 145b selects a position of gripping the materials G to be incinerated in the input area in a case of inputting the materials G to be incinerated from the input area into the hopper 11. For example, the gripping position selection unit 145b selects a position of gripping the materials G to be incinerated
 10 based on comparison of the detection result of one or more sensors described above with a threshold Td set in advance.

[0082]

(Operation Control Unit)

The operation control unit 146 executes the movement of each crane 30 and the
 15 gripping of the materials G to be incinerated by transmitting a control signal to a control panel of each crane 30. For example, the operation control unit 146 causes the crane 30 to execute work or the mixing method selected by the work selection unit 145a. The operation control unit 146 moves the crane 30 to the gripping position selected by the gripping position selection unit 145b and causes the crane 30 to grip the materials G to be incinerated.

20 [0083]

In a case where a plurality of cranes 30 are likely to interfere with each other, the operation control unit 146 determines the priority of the plurality of cranes 30 based on a classification of work to be executed or scheduled to be executed by each crane 30. Then, the operation control unit 146 avoids the interference between the cranes 30 by transmitting
 25 an avoidance instruction to the crane 30 with low priority among the plurality of cranes 30

likely to interfere with each other. As the priority set for the classification of the work, for example, the priority of the "input work" is highest, the priority of the "acceptance work" is second highest, and the priority of the "restacking work" is low. Note that the priority may be replaced at any time according to the degree of progress of mixing of each area, the waste height of the acceptance source area, or the like. Information indicating the priority is registered in a priority information DB 163 of the storage unit 160.

[0084]

<3.5 Setting Reception Unit>

Next, the setting reception unit 150 will be described.

The setting reception unit 150 receives various settings designated by the operator by receiving information for setting transmitted from the input device 51. Various settings include, for example, a type of an index for use in determination or selection and the magnitude of various thresholds. Various thresholds include, for example, the thresholds Ta and Tb that are used for selecting work to be executed from among a plurality of types of works set corresponding to the acceptance mode or the input mode, the threshold Tc that is used for selecting the mixing method to be executed from among two or more mixing methods, and the threshold Td that is used for selecting the gripping position of the materials G to be incinerated. Various settings described above are registered in a determination condition DB 164 of the storage unit 160.

[0085]

The type of the index or various thresholds (for example, the thresholds Ta, Tb, Tc, and Td) described above are set according to the equipment content (one or more of the waste acceptance processing amount of the incineration plant 1, the furnace processing capacity, furnace disposition, the number of furnaces, the scale of the waste pit, the number of cranes, and the like) of the incineration plant 1 or the operation policy of the incineration plant 1. In

a case where the equipment content or the operation policy of the incineration plant 1 is changed, the type of the index or various thresholds (for example, the thresholds Ta, Tb, Tc, and Td) are reset according to the equipment content or the operation policy of the incineration plant 1 after change.

5 [0086]

In other words, in a case where the equipment content or the operation policy of the incineration plant 1 is changed, the setting reception unit 150 can receive the change of the thresholds Ta and Tb such that the selection result of the work selection unit 145a selecting work to be executed among a plurality of types of works associated with the acceptance mode or the input mode is different. In a case where the equipment content or the operation policy of the incineration plant 1 is changed, the setting reception unit 150 can receive the change of the threshold Tc such that the selection result of the work selection unit 145a selecting a mixing method to be executed among a plurality of mixing methods is different. In a case where the equipment content or the operation policy of the incineration plant 1 is changed, the setting reception unit 150 can receive the change of the threshold Td such that the selection result of the gripping position selection unit 145b selecting the gripping position of actually gripping the materials G to be incinerated among a plurality of gripping position candidates is different.

[0087]

20 <3.6 Storage Unit>

The storage unit 160 stores various kinds of information. For example, the storage unit 160 stores the area function DB 161, the operation mode DB 162, the priority information DB 163, and the determination condition DB 164 described above.

[0088]

25 <4. Derivation of Operation Plan>

Next, derivation of an operation plan of the crane 30 will be described. In the present disclosure, the term "operation plan" is a plan indicating a basic operation of the crane 30, and means a plan of which the control content can be changed by changing the type of the index or various thresholds (for example, the thresholds Ta, Tb, Tc, and Td) described above.

[0089]

FIG. 12 is a flowchart illustrating a flow of an operation planning method of the crane 30. First, a plurality of area usage methods that can be set for a plurality of areas in the waste pit 21 are registered as the area function DB 161 (S101). The setting reception unit 150 receives the registration of the plurality of area usage methods described above. As described above, the plurality of area usage methods are not created for a specific incineration plant, and are an operation pattern of each area patterned in advance to be set for an arbitrary incineration plant.

[0090]

Next, a plurality of operation modes to be set for the plurality of cranes 30 are registered as the operation mode DB 162 (S102). The setting reception unit 150 receives the registration of the plurality of operation modes described above. As described above, the operation modes are not created for a specific incineration plant, and are an operation pattern of each crane 30 patterned in advance to be set for an arbitrary incineration plant. A plurality of work contents such as the acceptance work, the restacking work, and the input work are associated with each operation mode. One or more (for example, two or more) mixing methods are associated with each of a plurality of work contents of each operation mode.

[0091]

Next, a plurality of area usage methods and a plurality of operation modes are

selectively combined to derive the operation plan of the plurality of cranes 30 according to the equipment content or the operation policy of the incineration plant 1 (S103). In the present disclosure, the term "combine" is not limited to directly associating the area usage method and the operation mode, and can correspond to defining the crane 30 that mainly operates in a specific area by setting a specific area usage method for the specific area and setting a specific operation mode for a specific crane 30 or restricting an area where the above-described specific crane 30 moves. The control unit 140 derives the operation plan of the plurality of cranes 30 based on a selective combination of a plurality of area usage method and a plurality of operation modes set according to the equipment content or the operation policy of the incineration plant 1. In the present disclosure, the phrase "derive the operation plan ... according to the equipment content or the operation policy" includes, for example, setting the area usage method at each predetermined time for a plurality of areas in the pit and the operation mode for a plurality of cranes according to the equipment content or the operation policy and defining the operation plan of the plurality of cranes 30 by the combination. The phrase "according to the equipment content or the operation policy" means, for example, setting the area usage method or the operation mode of the crane based on one or more of the waste acceptance processing amount, the furnace processing capacity, the number of furnaces, and the scale of the waste pit included in the equipment content.

[0092]

Next, the type of the index or various thresholds (for example, the thresholds Ta, Tb, Tc, and Td) for selecting (switching) the work content of the crane 30, the mixing method, or the like in each operation mode according to the equipment content or the operation policy of the incineration plant 1 are registered (S104). The setting reception unit 150 receives the registration of the type of the index or various thresholds. With this, details of control contents of the crane 30 in the above-described operation plan are specified.

[0093]

<5. Flow of Control of Crane>

Next, a flow of control of the crane 30 will be described. Here, first, a flow of control of the crane 30 set in the input mode will be described.

5 [0094]

<5.1 Control of Crane in Input Mode>

FIGS. 13 to 15 are flowcharts illustrating a flow of control of the crane 30 in the input mode. Hereinafter, the crane 30 set in the input mode is referred to as an "input crane 30T". On the other hand, the crane 30 set in the acceptance mode is referred to as an "acceptance crane 30U". Hereinafter, a state in which the acceptance destination area is set for the first area A1 and the input area is set for the second area A2 is referred to as "area setting A". A state in which the input area is set for the first area A1 and the acceptance destination area is set for the second area A2 is referred to as "area setting B".

10

[0095]

15 (Input Work)

First, the selection unit 145 determines whether there is the input request signal from the hopper 11 (S201). In a case where there is no input request signal from the hopper 11 (S201; NO), the selection unit 145 determines that the input work is not required, and proceeds to processing regarding the acceptance work or the restacking work.

20 [0096]

On the other hand, in a case where there is the input request signal from the hopper 11 (S201; YES), the selection unit 145 selects one arbitrary section R where the overall evaluation value or the waste height is equal to or greater than a predetermined reference value, as a section R where the materials G to be incinerated are to be gripped, from among a plurality of sections R in the input area (S202).

25

[0097]

Next, the operation control unit 146 transmits an instruction to execute the "vertical mixing" associated with the input mode to the input crane 30T (S203). With this, the vertical mixing is performed for the section R selected in the processing of S202. Next, the operation control unit 146 transmits an instruction to execute the "input operation" associated with the input mode to the input crane 30T (S204). With this, the materials G to be incinerated are gripped in the section R selected in the processing of S202, and the materials G to be incinerated are input into the hopper 11.

[0098]

10 (Acceptance Work)

As illustrated in FIG. 14, in a case where the acceptance work is to be performed, the selection unit 145 determines whether there is the section R where the waste mound height is equal to or greater than a threshold T1 set in advance, from among a plurality of sections R included in the acceptance source area (for example, the dedicated acceptance source area associated with the input crane 30T) (S301). In a case where a determination result of S301 is negative (S301; NO), the selection unit 145 determines that the acceptance work is not required, and proceeds to processing regarding the restacking work.

[0099]

On the other hand, in a case where the determination result of S301 is affirmative (S301; YES), the selection unit 145 executes the acceptance work. In this case, the selection unit 145 selects one section R where the waste mound height is highest, from among a plurality of sections R determined in the processing of S301 (S302). In a case where there are a plurality of sections R where the waste mound height is the same and highest, a section R closest to the input crane 30T from among the plurality of sections R is selected.

25 [0100]

Next, the selection unit 145 selects a column including the section R where the waste height is lowest, in the acceptance destination area (S303). Next, the operation control unit 146 transmits an instruction to execute the "moving and scattering mixing" associated with the restacking work of the input mode to the input crane 30T (S304). With this, the

5 materials G to be incinerated are gripped in the section R selected in the processing of S302, and the gripped materials G to be incinerated are subjected to the moving and scattering mixing along the column selected in S303. In the present embodiment, in a case where the materials G to be incinerated are moved from the dedicated acceptance source area of the input crane 30T to the acceptance destination area, the input crane 30U is retracted. That is,

10 the input crane 30T that performs the "acceptance work" included in the input mode has priority over the acceptance crane 30U that performs any type of work included in the acceptance mode.

[0101]

(Restacking Work)

15 As illustrated in FIG. 15, in a case where the restacking work is to be performed, the selection unit 145 determines whether or not there is the section R where the waste mound height is equal to or greater than a threshold T2 set in advance, from among the plurality of sections R in the input area (S401). In a case where there is no section R where the waste mound height is equal to or greater than the threshold T2, from among the plurality of

20 sections R in the input area (S401; NO), the selection unit 145 returns to the processing of S201.

[0102]

On the other hand, in a case where there are a plurality of sections R where the waste mound height is equal to or higher than the threshold T2, from among the plurality of

25 sections R in the input area (S401; YES), the selection unit 145 selects the section R where

the waste mound height is highest, from among the plurality of sections R as a restacking source candidate (S402). In a case where a plurality of sections R where the waste mound height is the same are detected, the selection unit 145 selects one section R where the overall evaluation value is highest, from among the plurality of sections R. In a case where a plurality of sections R where the overall evaluation value is the same and highest, are detected from among the plurality of sections R, the selection unit 145 selects the section R closest to the input crane 30T from among the plurality of sections R where the overall evaluation value is the same and highest.

[0103]

Next, the selection unit 145 selects the section R where the waste mound height is lowest, from among the plurality of sections R in the input area as a restacking destination candidate (S403). In a case where a plurality of sections R where the waste mound height is the same are detected, the selection unit 145 selects one section R where the overall evaluation value is lowest, from among the plurality of sections R. In a case where a plurality of sections R where the overall evaluation value is the same and lowest, are detected from among the plurality of sections R, the selection unit 145 selects the section R closest to the input crane 30T from among the plurality of sections R where the overall evaluation value is the same and lowest.

[0104]

Here, in a case where the acceptance crane 30U is in a predetermined area (for example, the sections R within two columns near the boundary between the acceptance area and the input area) near the boundary between the acceptance destination area and the input area, the selection unit 145 selects the section R of the restacking source candidate and the section R of the restacking destination candidate described above from among a plurality of sections R in the input area excluding a predetermined area (for example, the sections R

within two columns near the boundary between the acceptance area and the input area) near the boundary between the acceptance destination area and the input area. In other words, the acceptance crane 30U that performs any type of work included in the acceptance mode has priority over the input crane 30T that performs the "restacking work" included in the

5 input mode.

[0105]

Next, the operation control unit 146 transmits an instruction to execute the "moving mixing" associated with the restacking work of the input mode to the input crane 30T (S404). With this, the materials G to be incinerated are gripped in the section R selected in the

10 processing of S402, and the gripped materials G to be incinerated is restacked to the section R selected in the processing of S403 by the moving mixing.

[0106]

<5.2 Control of Crane in Acceptance Mode>

Next, control of the acceptance crane 30U will be described.

15 FIG. 16 is a flowchart illustrating a flow of control of the acceptance crane 30U and illustrates a flow of the "acceptance work" included in the acceptance mode. The acceptance work by the acceptance crane 30U is similar to the acceptance work by the input crane 30T excluding moving the materials G to be incinerated from the section R (the section R of the specific area) other than the dedicated acceptance source area where the crane 30 set

20 in the input mode is dedicated, in the acceptance source area to the acceptance destination area. For this reason, in regard to the description of the acceptance work by the acceptance crane 30U, in the above description regarding the acceptance work by the input crane 30T, "input crane 30T" may be replaced with "acceptance crane 30U", and "the dedicated acceptance source area associated with the input crane 30T" may be replaced with "the

25 section R of the specific area in the acceptance source area".

[0107]

In regard to the description of the restacking work by the acceptance crane 30U, in the above description regarding the restacking work by the input crane 30T, "input crane 30T" may be replaced with "acceptance crane 30U", and "input area" may be replaced with
 5 "acceptance destination area".

[0108]

The thresholds T1 and T2 appeared in the above description are thresholds included in any of the above-described thresholds Ta, Tb, Tc, and Td, and can be changed according to the equipment content or the operation policy of the incineration plant 1.

10 [0109]

<5. Advantages>

A recent waste pit has a horizontally long area in many cases since post-stage incinerators are disposed right and left, and acceptance, mixing, and input of materials G to be incinerated are performed by a plurality of cranes according to a waste acceptance amount
 15 or the size of the incinerator. Note that, in a case where work is performed by operating a plurality of cranes simultaneously, there is a risk that interference between the cranes occurs, and it is difficult to perform an automatic operation. Logics for controlling the automatic operation of the cranes such as the waste acceptance processing amount of the incineration plant, the furnace processing capacity, furnace disposition, the number of furnaces, the scale
 20 of the waste pit, and the number of cranes require examination and change of the plan or the policy for each incineration plant.

[0110]

On the other hand, in the present embodiment, the control device 100 includes the area function setting unit 120, the operation setting unit 130, and the control unit 140. The
 25 area function setting unit 120 sets the area usage method at the predetermined time for each

of a plurality of areas in the waste pit 21 where the materials G to be incinerated are deposited. The operation setting unit 130 sets the operation mode for each of a plurality of cranes 30. The control unit 140 controls each of the plurality of cranes 30 based on a combination of the area usage method set by the area function setting unit 120 and the
5 operation mode set by the operation setting unit 130.

[0111]

According to such a configuration, it is possible to easily perform operation automation of a plurality of cranes 30 by defining a plurality of area usage methods and a plurality of operation modes in advance, patterning the inside of a control logic in which
10 every change becomes complicated due to a scale of target equipment, the number of pieces of equipment, or the like, and deriving the operation plan by a suitable combination. For example, the crane 30 that mainly operates for each area is restricted (or a movement range is restricted for each crane 30) by the area usage method and the operation mode, and it is possible to reduce a risk of interference between the cranes 30. With this, it is possible to
15 easily perform operation automation of a plurality of cranes 30.

[0112]

Although the embodiment of the present disclosure has been described above in detail with reference to the drawings, a specific configuration is not limited to the embodiment, and the present disclosure includes design changes and the like without
20 departing from the gist of the present disclosure.

[0113]

FIG. 17 is a hardware configuration diagram illustrating a configuration of a computer 1100 according to the present embodiment. The computer 1100 includes, for example, a processor 1110, a main memory 1120, a storage 1130, and an interface 1140.

25 [0114]

Each functional unit of the control device 100 described above is mounted in the computer 1100. Then, the operation of each functional unit described above is stored in the storage 1130 in a format of a program. The processor 1110 reads the program from the storage 1130, develops the program to the main memory 1120, and executes the above-

5 described processing according to the program. The processor 1110 reserves a storage region that is used by each functional unit described above, in the main memory 1120 according to the program.

[0115]

The program may be for implementing some of the functions that the computer 1100

10 exhibits. For example, the program may cause the functions to be exhibited in combination with other programs already stored in the storage 1130 or in combination with other programs mounted in other devices. The computer 1100 may include a custom large scale integrated circuit (LSI) such as a programmable logic device (PLD) in addition to the above-described configuration or instead of the above-described configuration. Examples of the PLD

15 include a programmable array logic (PAL), a generic array logic (GAL), a complex programmable logic device (CPLD), and a field programmable gate array (FPGA). In this case, some or all of the functions that are implemented by the processor 1110 may be implemented by the integrated circuit.

[0116]

20 Examples of the storage 1130 include a magnetic disk, a magneto-optical disk, and a semiconductor memory. The storage 1130 may be an internal medium directly connected to a bus of the computer 1100 or may be an external medium that is connected to the computer 1100 via the interface 1140 or a communication line. In a case where the program is distributed to the computer 1100 via a communication line, the computer 1100 that receives

25 the program may develop the program to the main memory 1120, and may execute the above-

described processing. The program may be for implementing some of the functions described above. The program may be a so-called difference file (difference program) that implements the above-described functions in combination with other programs already stored in the storage 1130.

5 [0117]

<Additional Notes>

The control system and the operation planning method described in each embodiment are understood as follows, for example.

[0118]

10 (1) A control system of a first aspect includes an area function setting unit 120 configured to set an area usage method at a predetermined time for each of a plurality of areas in a pit (for example, a waste pit 21) where materials G to be incinerated are deposited, an operation setting unit 130 configured to set an operation mode for each of a plurality of cranes 30, and a control unit 140 configured to control each of the plurality of cranes 30
 15 based on a combination of the area usage method set by the area function setting unit 120 and the operation mode set by the operation setting unit 130. According to such a configuration, it is possible to easily perform operation automation of a plurality of cranes 30 by deriving the operation plan by the combination of the area usage method and the operation mode. For example, the crane 30 that mainly operates for each area is restricted (or the movement
 20 range is restricted for each crane 30) by the area usage method and the operation mode, and it is possible to reduce a risk of interference between the cranes 30.

[0119]

(2) A control system of a second aspect is the control system of the first aspect, in which the plurality of areas include at least a first area A1 and a second area A2, the area
 25 function setting unit 120 is configured to set an acceptance destination area where an input of

the materials G to be incinerated into a hopper 11 is prevented and the materials G to be incinerated are accepted, to the first area A1 and set an input area where the materials G to be incinerated are input into the hopper 11, to the second area A2 as the area usage method at a first time, and set the input area for the first area A1 and set the acceptance destination area
 5 for the second area A2 as the area usage method at a second time different from the first time. According to such a configuration, it is possible to separately manage the movement of the cranes 30 between the area regarding acceptance and the area regarding input. With this, it is possible to more easily perform operation automation of a plurality of cranes 30. For example, it is possible to further reduce a risk of interference between the cranes 30.

10 [0120]

(3) A control system of a third aspect is the control system of the first aspect or the second aspect, in which the plurality of cranes 30 include at least a first crane 30A and a second crane 30B, and the operation setting unit 130 is configured to set an acceptance mode where an input of the materials G to be incinerated into a hopper 11 is prevented and the
 15 materials G to be incinerated are accepted, to the first crane 30A and set an input mode where the materials G to be incinerated are input into the hopper 11, to the second crane 30B as the operation mode at the first time, and set the input mode for the first crane 30A and set the acceptance mode for the second crane 30B as the operation mode at the second time.

According to such a configuration, it is possible to separately manage the movement of the
 20 cranes 30 between the crane in charge of acceptance and the crane in charge of input. With this, it is possible to more easily perform operation automation of a plurality of cranes 30. For example, it is possible to reduce a risk of interference between the cranes 30.

[0121]

(4) A control system of a fourth aspect is the control system of the third aspect, in
 25 which a plurality of types of work including acceptance work of accepting the materials G to

be incinerated and restacking work of restacking the materials G to be incinerated in the acceptance destination area are associated with the acceptance mode, a plurality of types of work including input work of inputting the materials G to be incinerated into the hopper 11 and restacking work of restacking the materials G to be incinerated in the input area are associated with the input mode, and the control unit 140 is configured to switch work to be executed among the plurality of types of work associated with the acceptance mode based on a request from an incinerator 3 or a detection result of one or more sensors in relation to a crane 30 set in the acceptance mode among the plurality of cranes 30, and switch work to be executed among the plurality of types of work associated with the input mode based on a request from the incinerator 3 or a detection result of the one or more sensors in relation to a crane 30 set in the input mode among the plurality of cranes 30. According to such a configuration, a plurality of types of work are defined in association with the operation mode, and control to be actually executed is switched based on the request from the incinerator 3 or the detection result of one or more sensors. With this, it is possible to more easily perform the automatic operation of the cranes 30.

[0122]

(5) A control system of a fifth aspect is the control system of the fourth aspect, further including a setting reception unit 150 configured to receive a setting by an operator, in which, as a mixing method of the materials G to be incinerated, one or more of vertical mixing, moving mixing, and moving and scattering mixing is executed in association with at least one type of work among the plurality of types of work associated with the acceptance mode or the input mode based on the setting received by the setting reception unit 150 or a detection result of the one or more sensors. According to such a configuration, it is possible to execute the at least one type of work by combining (for example, suitably recombining) arbitrary mixing methods defined in advance. With this, it is possible to more easily

perform the automatic operation of the cranes 30.

[0123]

- (6) An operation planning method according to a sixth aspect is an operation planning method for a plurality of cranes 30 that are operated in a storing section 2 of materials G to be incinerated, the operation planning method causing a computer to execute registering a plurality of area usage methods to be set for a plurality of areas in a pit (for example, a waste pit 21) of the storing section 2, registering a plurality of operation modes to be set for the plurality of cranes 30, and selectively combining the plurality of area usage methods and the plurality of operation modes according to an equipment content or an operation policy of the storing section 2 to derive an operation plan of the plurality of cranes 30. According to such a configuration, it is possible to easily perform operation automation of a plurality of cranes 30 by deriving the operation plan by the combination of the area usage method and the operation mode. For example, the crane 30 that mainly operates for each area is restricted by the area usage method and the operation mode, and it is possible to reduce a risk of interference between the cranes 30.

Industrial Applicability

[0124]

According to the present disclosure, it is possible to easily perform operation automation of a plurality of cranes.

20 Reference Signs List

[0125]

- 1 Incineration plant
- 2 Storing section
- 3 Incinerator
- 25 11 Hopper

	11A First hopper
	11B Second hopper
	21 Waste pit
	30 Crane
5	30A First crane
	30B Second crane
	100 Control device (control system)
	110 Information acquisition unit
	120 Area function setting unit
10	130 Operation setting unit
	140 Control unit
	141 Waste height calculation unit
	142 Mixing frequency calculation unit
	143 Bulk specific gravity calculation unit
15	144 Evaluation value calculation unit
	145 Selection unit
	146 Operation control unit
	150 Setting reception unit

CLAIMS

[Claim 1] A control system comprising:

- an area function setting unit configured to set an area usage method at a
5 predetermined time for each of a plurality of areas in a pit where materials to be incinerated
are deposited;
- an operation setting unit configured to set an operation mode for each of a plurality
of cranes; and
- a control unit configured to control each of the plurality of cranes based on a
10 combination of the area usage method set by the area function setting unit and the operation
mode set by the operation setting unit,
- wherein the plurality of areas include at least a first area and a second area, and
the area function setting unit is configured to
set an acceptance destination area where an input of the materials to be incinerated
15 into a hopper of an incinerator is prevented and the materials to be incinerated are accepted,
to the first area and set an input area where the materials to be incinerated are input into the
hopper, to the second area as the area usage method at a first time, and
set the input area for the first area and set the acceptance destination area for the
second area as the area usage method at a second time different from the first time.

20 [Claim 2] The control system according to claim 1,

- wherein the plurality of cranes include at least a first crane and a second crane, and
the operation setting unit is configured to
set an acceptance mode where the input of the materials to be incinerated into the
hopper is prevented and the materials to be incinerated are accepted, to the first crane and set
25 an input mode where the materials to be incinerated are input into the hopper, to the second

crane as the operation mode at the first time, and

set the input mode for the first crane and set the acceptance mode for the second crane as the operation mode at the second time.

[Claim 3] The control system according to claim 2,

5 wherein a plurality of types of work including acceptance work of accepting the materials to be incinerated and restacking work of restacking the materials to be incinerated are associated with the acceptance mode,

a plurality of types of work including input work of inputting the materials to be incinerated into the hopper and restacking work of restacking the materials to be incinerated

10 are associated with the input mode, and

the control unit is configured to

switch work to be executed among the plurality of types of work associated with the acceptance mode based on a request from the incinerator or a detection result of one or more sensors in relation to a crane set in the acceptance mode among the plurality of cranes, and

15 switch work to be executed among the plurality of types of work associated with the input mode based on a request from the incinerator or a detection result of the one or more sensors in relation to a crane set in the input mode among the plurality of cranes.

[Claim 4] The control system according to claim 3, further comprising:

a setting reception unit configured to receive a setting by an operator,

20 wherein, as a mixing method of the materials to be incinerated, one or more of vertical mixing, moving mixing, and moving and scattering mixing is executed in association with at least one type of work among the plurality of types of work associated with the acceptance mode or the input mode based on the setting received by the setting reception unit or a detection result of the one or more sensors.

25 [Claim 5] An operation planning method for a plurality of cranes that are operated in a

storing section of materials to be incinerated, the operation planning method comprising, by a computer:

registering a plurality of area usage methods to be set for a plurality of areas in a pit of the storing section;

5 registering a plurality of operation modes to be set for the plurality of cranes; and
selectively combining the plurality of area usage methods and the plurality of operation modes according to facility contents or an operation policy of the storing section to derive an operation plan of the plurality of cranes,

wherein the plurality of areas includes at least a first area and a second area, and
10 the plurality of area usage methods include
setting an acceptance destination area where an input of the materials to be incinerated into a hopper of an incinerator is prevented and the materials to be incinerated are accepted, to the first area and setting an input area where the materials to be incinerated are input into the hopper, to the second area as the area usage method at a first time, and
15 setting the input area to the first area and setting the acceptance destination area to the second area as the area usage method at a second time different from the first time.